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GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS
(Railway Board)

BRIDGE RULES

(IN SI UNITS)

RULES SPECIFYING THE LOADS FOR DESIGN OF SUPER-STRUCTURE AND SUB-STRUCTURE OF BRIDGES AND FOR ASSESSMENT OF THE STRENGTH OF EXISTING BRIDGES

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BRIDGE RULES

RULES SPECIFYING THE LOADS FOR DESIGN OF THE SUPER-STRUCTURE AND SUB-STRUCTURE OF BRIDGES AND FOR ASSESSMENT OF THE STRENGTH OF EXISTING BRIDGES

1.0 SCOPE

1.1 The loads specified herein shall be taken into consideration in calculating the strength of all bridges, including turntable girders and foot-bridges but excluding road bridges in which case, the loads to be considered shall be in accordance with the Standard Specifications and Codes of Practice for Road Bridges (IRC Codes). The details of design shall be controlled by the appropriate Codes of Practice as given below:

(a) The design of steel bridges shall be in accordance with the Indian Railway Standard Code of Practice for the Design of Steel or Wrought Iron Bridges carrying Rail, Road or Pedestrian Traffic (Steel Bridge Code).

(b) The design of concrete bridges shall be in accordance with the Indian Railway Standard Code of Practice for Plain, Reinforced and Prestressed Concrete for General Bridge Construction (Concrete Bridge Code).

(c) The design of masonry and plain concrete arch bridges shall be in accordance with the Indian Railway Standard Code of Practice for the Design and Construction of Masonry and Plain Cement Concrete Arch Bridges (Arch Bridge Code).

(d) The design of sub-structures of bridges shall be in accordance with the Indian Railway Standard Code of Practice for the design of Sub-structures of Bridges (Bridge Sub-Structure Code).

(e) The design of sub-structures and super-structures of road bridges shall be in accordance with Standard Specification and Codes of Practice for Road Bridges and other codes as specified by the appropriate authorities.

(f) The design of sub-structures and super-structures of rail-cum-road bridges shall be in accordance with the relevant Indian Railway Standard Codes of Practice except that the Standard Specifications and Codes of Practice for Road Bridges issued by the Indian Roads Congress may apply for the design of such members as are subjected to loads from road traffic alone.

NOTE:

(1) *Unless otherwise specified the word 'Span' shall mean effective span.*

(2) *SI and Metric system of units are given in all cases, but only one system of unit is to be adopted for the design.*

(3) *Attention is drawn to the fact that equations in the text, for which no units are specified, are applicable in any system of units - SI or Metric provided the unit of length and the unit of force used in an equation are the same throughout.*

1.2 Any revision or addition or deletion of the provisions of the Bridge Rules shall be issued only through the correction slip to these Bridge Rules. No cognizance shall be given to any policy directives issued through other means.

2.0 LOADS

2.1 For the purpose of computing stresses, the following items shall, where applicable, be taken into account:

(a) Dead load

(b) Live load

(c) Dynamic effects

(d) Forces due to curvature or eccentricity of track

(e) Temperature effect

(f) Frictional resistance of expansion bearings

(g) Longitudinal force

(h) Racking force

(i) Forces on parapets

(j) Wind pressure effect

(k) Forces and effects due to earthquake

(l) Erection forces and effects

(m) Derailment loads

(n) Load due to Plasser's Quick Relay System (PQRS)

2.2 DEAD LOAD

2.2.1 Dead load is the weight of the structure itself together with the permanent loads carried thereon.

2.2.2 For design of ballasted deck bridges, a ballast cushion of 400mm for BG and 300mm for MG shall be considered. However, ballasted deck bridges shall also be checked for a ballast cushion of 300mm on BG and 250mm on MG.

2.3 LIVE LOAD

2.3.1 Railway Bridges including combined Rail and Road bridges- Railway Bridges including combined rail and road bridges shall be designed for one of the following standards of railway loading:

(a) For Broad Gauge - 1676mm –

"25t Loading-2008" with a maximum axle load of 245.2 kN (25.0t) for the locomotives and a train load of 91.53 kN/m (9.33t/m) on both sides of the locomotives (Appendix-XXII)

NOTE:

(1) *Provided the Equivalent Uniformly Distributed Loads of a locomotive with any trailing load are within the EUDL of the Standard loading specified, a locomotive with axle loads heavier than the Standard loading or average trailing loads heavier than those specified in the standard, may be considered as falling under the corresponding standard for the particular span or spans. In such cases, the actual stresses are to be limited to the permissible stresses for the design stress cycles.*

(2) *Diagrams of Standard loading and Equivalent Uniformly Distributed Loads on each track for calculating Bending Moment and Shear Force are shown in the accompanying Appendices XXII, XXIII & XXIII (a) respectively.*

(3) *The above standard should be adopted for BG lines for all spans on routes as detailed below:*

(i) Building/Rebuilding/Strengthening/ Rehabilitation of Bridges for all routes except Dedicated Freight Corridor (DFC) feeder routes and DFC Loading Routes i.e. erstwhile HM Loading Routes.

(ii) Rehabilitation/Strengthening of Bridges on Dedicated Freight Corridor (DFC) feeder routes.

(iii) Superstructures of Bridges being built/rebuilt on DFC Feeder Routes.

In any special case where any loading other than the standard is proposed, specific orders of the Railway Board must be obtained.

(4) *EUDLs shall be used for simply supported spans. In case of continuous super-structures over supports, the Bending Moments and Shear Forces for design purposes at various sections shall be computed for loadings shown in Appendix-XXII.*

(b) For Broad Gauge-1676 mm

"DFC loading (32.5t axle load)" with a maximum axle load of 245.25 kN (25.0t) for the locomotives and a train load of 118.99

kN/m (12.13t/m) on both sides of the locomotives (Appendix-XXVI). The maximum axle load of wagons are 318.825 kN (32.5t).

NOTE:

(1) *Provided the Equivalent Uniformly Distributed Loads of a locomotive with any trailing load are within the EUDL of the Standard loading specified, a locomotive with axle loads heavier than the Standard loading or average trailing loads heavier than those specified in the standard, may be considered as falling under the corresponding standard for the particular span or spans. In such cases, the actual stresses are to be limited to the permissible stresses for the design stress cycles.*

(2) *Diagrams of Standard loading and Equivalent Uniformly Distributed Loads on each track for calculating Bending Moment and Shear Force for* "DFC loading (32.5t axle load)" *are given in the accompanying Appendices XXVI, XXVII & XXVII (a) respectively.*

(3) *(i) The above standard should be adopted for bridges on identified routes approved by Railway Board.*

(ii) Building/Rebuilding/Strengthening/ Rehabilitation of bridges on DFC Loading Route i.e. erstwhile HM Loading Routes.

(iii) Besides this, the above standard should be adopted for Building/ rebuilding of substructure ONLY on Dedicated Freight Corridor (DFC) Feeder Routes. For rebuilding of super structure on Dedicated Freight Corridor (DFC) Feeder Routes, refer note no. 3(iii) of clause No. 2.3.1(a).

(4) *EUDLs shall be used for simply supported spans. In case of continuous super-structures over supports, the Bending Moments and Shear Forces for design purposes at various sections shall be computed for loadings shown in Appendix-XXVI.*

(c) For Metre Gauge-1000mm

(i) Modified Metre Gauge Loading-1988 with maximum axle load of 156.9 kN (16.0 t) for locomotives and a train load of 53.9 kN (5.5t) per metre on both sides of locomotives with maximum axle load of 137.29 kN (14.0t) for the trainload.

(ii) Standard M.L. of 1929 for 129.4 kN (13.2t) axle loads and a train load of 37.95 kN (3.87t) per metre behind the engines.

(iii) Standard B.L. of 1929 for 104.9 kN (10.7 t) axle loads and a train load of 37.95 kN (3.87 t) per metre behind the engines.

(iv) Standard C of 1929 for 79.4 kN (8.1 t) axle loads and a train load of 37.95 kN (3.87 t) per metre behind the engines.

NOTE:

(1) *Provided the Equivalent Uniformly Distributed Loads of a locomotive with any trailing load are within the EUDL of the Standard loading specified, a locomotive with axle loads heavier than the standard loading or average trailing loads heavier than those specified in the standard may be considered as falling under the corresponding standards for the particular span or spans. In such cases, the actual stresses are to be limited to the permissible stresses for the design stress cycles.*

(2) *Diagrams of standard loadings are shown in Appendices V and V (a). EUDL, on each track for calculating Bending Moment and Shear, in kN (t) are given in Appendix III. EUDL for Bending Moment/Shear Force in kN (t) for cushion of various depths and spans upto and including 8m are given in Appendices III (a), III (b), III(c) and III (d), for various Metre Gauge Standard Loadings.*

(3) *Modified Metre Gauge Loading-1988– This standard will apply while constructing new bridges or rebuilding/strengthening of existing bridges on the Metre Gauge routes, where the running, of heavier freight wagons and more powerful locos is envisaged, besides those which are identified for upgradation.*

(4) *Main Line Standards – For such Main Lines where Modified MG Loading-1988 is not required, ML standards should be adopted.*

(5) *Branch Line Standard - Branch Lines which are obviously never likely to be other than Branch Lines, should have all bridges built to BL standard of loading unless the branch be in a heavy mineral area in which case the provision of Note (3) above should be adopted.*

(6) *EUDLs shall be used for simply supported spans. In case of continuous super-structure over supports, the Bending Moments and Shear Forces for design purposes at various sections shall be computed for loadings shown in Appendices V and V (a).*

(d) For Narrow Gauge-762 mm

(i) 'H' (Heavy) class loading with a maximum axle load of 95.1 kN (9.7 t) and a train load of 27.8 kN (2.83 t) per metre behind the engines.

(ii) 'A' class Main Line loading with a maximum axle load of 79.4 kN (8.1 t) and a train load of 27.8 kN (2.83 t) per metre behind the engines.

(iii) 'B' class Branch Line loading with a maximum axle load of 59.8 kN (6.1 t) and a train load of 27.8 kN (2.83 t) per metre behind the engines.

NOTE:

Diagrams of Standard loading and Equivalent Uniformly Distributed Loads on each track for calculating Bending Moment and Shear Force are shown in the accompanying Appendices I & II.

(e) For Narrow Gauge-610mm

The Standard will be specified by the Railway Board from time to time.

2.3.1.1 For analysis and design of the new bridges, the EUDL approach shall be used. However, exact analysis for maximum Bending Moment and Shear Forces can also be carried out with the help of software "Moving Load" issued by RDSO.

2.3.2 Footbridges and footpaths on Bridges

2.3.2.1 The live load due to pedestrian traffic shall be treated as uniformly distributed over the footway. For the design of footbridges or footpaths on railway bridges the live load including dynamic effects shall be taken as 4.8 kPa (490 kg/m^2) of the footpath area. For the design of foot-path on a road bridge or road rail bridge, the live load including dynamic effects may be taken as 4.07 kPa (415 kg/m^2) except that, where crowd loading is likely, this may be increased to 4.8 kPa (490 kg/m^2).

2.3.2.2 Where footpaths are provided on a road or Railway Bridge the load on footpath for the purpose of designing the main girders shall be taken as follows:

(a) For effective spans of 7.5m or less 4.07 kPa (415 kg/m^2).

(b) For effective spans over 7.5m but not exceeding 30m - an intensity of load reducing uniformly from 4.07 kPa (415 kg/m^2) for a span of 7.5m to 2.89 kPa (295 kg/m^2) for a span of 30m.

(c) For effective spans over 30m according to the formula:

$$P = \left\{13.3 + \frac{400}{L}\right\}\left\{\frac{17 - W}{142.8}\right\} \text{KPa}$$

OR

$$P = \left\{13.3 + \frac{400}{L}\right\}\left\{\frac{17 - W}{1.4}\right\} \text{Kg/m}^2$$

Where,

P = Live load in kPa (kg/m^2)

L = Effective span of the bridge in m

W = Width of the foot-way in m

2.3.2.3 Where footpaths are provided on a combined rail road bridge, the load on foot- path for purpose of designing the main girders shall be taken as 1.91 kPa (195 kg/m^2).

In case of footpath on a combined rail and road bridge, where the failure of a footpath due to a roadway vehicle mounting the kerb, is likely to endanger railway traffic, the footpath may be designed for a heavier standard of loading.

2.3.2.4 Kerbs 600mm (2 ft) or more in width shall be designed for the loads in 2.3.2.1 in addition to the lateral loading of 7.35 kN/m (750 kg/m) run of the kerb applied horizontally at the top of the kerb. If the kerb width is less than 600mm, no live load shall be applied in addition to the lateral load specified above. These loads need not be taken for the design of the supporting structures.

2.3.3 Combined Rail and Road Bridges

2.3.3.1 Main Girders

(a) Where railway and road decks are not common, that is if they are at different levels, or side by side, the main girders will be designed for the worst combination of live loads with full allowance for dynamic effects for train loads only. No allowance for dynamic effects shall be allowed for roadway loading.

(b) Where railway and road decks are common, the effect of roadway and footpath loads on main girders shall be provided for by any allowance of 1.9 kPa (195 kg/m^2) as a minimum over the whole area of the roadways and footpaths not occupied by the train load.

2.3.3.2 Floor Members and their Connections

(a) Roadway floor members shall be designed for the full effect of the maximum live load including dynamic effect, which may occur on the roadway.

(b) Floor members, which carry or may carry roadway and railway loads simultaneously shall be designed by the maximum effect, including dynamic effects which may be imposed by either class of load separately or together.

(c) In cases, where the roadway and railway are on the same alignment, the floor members and their connections shall be designed for the maximum effect of either class of load.

(d) The roadway floor system of combined bridges carrying two traffic lanes for roads for class AA loading shall be designed on the assumption that two class AA vehicles may be placed opposite to each other on the centre lines of each traffic lane at any position in a panel. Under this condition of loading the over stresses specified for occasional loads shall apply.

2.3.4 Longitudinal and Lateral Distribution of Railway Live load

2.3.4.1 For the design of various types of bridges, the loads as given in the Table below should be considered.

TABLE

S. No.	Span and types	Loading
1	Simply supported span-unballasted deck. All spans.	EUDL as given in Appendices III, XXIII & XXVII for relevant standard of loading.
2	Simply supported span-ballasted deck.	
2.1	Spanning at right angle to the direction of traffic. All spans.	A single sleeper load equal to the heaviest axle of relevant standard of loading, allowing dispersal as indicated in Clause 2.3.4.2.
2.2	Spanning in the direction of traffic.	
2.2.1	Spans upto and including 8m for cushion upto and including 600mm under the sleeper.	EUDL for Bending Moment and Shear shall be as per values given in Appendices III (a), III (b), III (c), III (d), XXIII (a) and XXVII (a) for the relevant standard of loading.
2.2.2	Spans upto and including 8m for cushion above 600mm under the sleeper.	EUDL for Bending Moment and Shear shall be as per the values for 600mm cushion given in Appendices III(a), III (b), III (c), III (d) , XXIII (a) and XXVII (a) for the relevant standard of loading.
2.2.3	Spans above 8m both for BG and MG for all cushions.	EUDL for Bending Moment and Shear shall be as per the values given in Appendices III, XXIII and XXVII for the relevant standard of loading.
3	Spandrel filled arches.	
3.1	Spans upto and including 8m, for cushion 300mm and above but less than 600mm.	EUDL for Bending Moment and Shear shall be as per values given in Appendices III(a), III (b), III(c), III (d) , XXIII(a) and XXVII(a) for the relevant standard of loading.
3.2	Spans upto and including 8m for cushion 600mm and above under the sleeper.	EUDL for the Bending Moment and Shear shall be as per the values for 600mm cushion given in Appendices III (a), III (b), III(c), III (d), XXIII(a) and XXVII(a) for the relevant standard of loading.
3.3	Spans above 8m both for BG and MG for all cushions.	EUDL as given in Appendices III, XXIII and XXVII for relevant standard of loading.
4	Open spandrel arches. All spans.	Series of axle loads corresponding to appropriate standard of loading given in Appendices V, V(a), XXII and XXVI.
5	Pipes	
5.1	Depth of cushion 300mm and above, but less than 600mm.	EUDL for Bending Moment and Shear shall be as per the values given in Appendices III (a), III (b), III(c), III(d), XXIII(a) and XXVII(a) for the relevant standard of loading.

S. No.	Span and types	Loading
5.2	Depth of cushion 600mm and above.	The pipes shall be designed for the following intensities of loading: **Loading** **t/m** DFC Loading 16.25 HM Loading 15.80 25t Loading-2008 13.70 MBG Loading-1987 13.70 MMG Loading-1988 9.80 MGML Loading 9.80 MGBL Loading 7.95 MG 'C' Loading 6.65 NG 'A' Loading 8.30
Note: Dynamic effect is to be added as per Clause 2.4. Dispersion of load through sleepers and ballast across the direction of traffic shall be as per Clause 2.3.4.2(a).		
6	Rigid frames, cantilevers and suspension bridges.	Series of axle loads corresponding to appropriate standard of loading given in Appendices V, V (a), XXII and XXVI.

2.3.4.2 Dispersion of railway live loads shall be as follows:

(a) **Distribution through sleepers and ballast:** The sleeper may be assumed to distribute the live load uniformly on top of the ballast over the area of contact given below:

Type I	Type II
	Under each rail seat
BG 2745mm x 254mm	760mm x 330mm
MG 1830mm x 203mm	610mm x 270mm

The load under the sleeper shall be assumed to be dispersed by the fill including ballast at a slope not greater than half horizontal to one vertical and all deck slabs shall be designed for both types of sleepers.

(b) **Distribution through R.C. Slab:** When there is effective lateral transmission of Shear Force, the load may be further distributed in a direction at right angles to the span of the slab equal to the following:

(i) ¼ span on each side of the loaded area in the case of simply supported, fixed and continuous spans.

(ii) ¼ of loaded length on each side of the loaded area in the case of cantilever slabs.

NOTE:

(1) *In no case shall the load be assumed to be distributed over a width greater than the total width of the decking for slabs spanning in the longitudinal direction and minimum axle spacing in the case of slabs spanning in transverse direction.*

(2) *No distribution through the slab may be assumed in the direction of the span of the slab.*

(c) The distribution of wheel loads on steel troughing or beams (steel or wooden) spanning transversely to the track, and supporting the rails directly shall be in accordance with Appendix H of Steel Bridge Code and the design shall be based on the continuous elastic support theory.

2.4 DYNAMIC EFFECT

2.4.1 Railway Bridges (Steel)

2.4.1.1 For Broad and Metre Gauge Railway: The augmentation in load due to dynamic effects should be considered by adding a load Equivalent to a Coefficient of Dynamic Augment (CDA) multiplied by the live load giving the maximum stress in the member under consideration. The CDA should be obtained as follows and shall be applicable upto 160 km/h on BG and 100 km/h on MG –

(a) For single track spans:

$$CDA=0.15+\frac{8}{(6+L)}$$

Subject to maximum of 1.0

Where **L** is

(1) the loaded length of span in metres for the position of the train giving the maximum stress in the member under consideration.

(2) 1.5 times the cross-girder spacing in the case of stringers (rail bearers) and

(3) 2.5 times the cross girder spacing in the case of cross girders.

(b) For main girders of double track spans with 2 girders, CDA as calculated above may be multiplied by a factor of 0.72 and shall be subject to a maximum of 0.72.

(c) For intermediate main girders of multiple track spans, the CDA as calculated in Clause 2.4.1.1(a) may be multiplied by a factor of 0.6 and shall be subject to a maximum of 0.6.

(d) For the outside main girders of multiple track spans with intermediate girders, CDA shall be that specified in Clause 2.4.1.1(a) or (b) whichever applies.

(e) For cross girders carrying two or more tracks, CDA as calculated in Clause 2.4.1.1(a) may be multiplied by a factor of 0.72 and shall be subject to a maximum of 0.72.

(f) Where rails, with ordinary fish-plated joints, are supported directly on transverse steel troughing or steel sleepers, the dynamic augment for calculating stresses in such troughing or sleepers shall be taken as

$$\frac{7.32}{B+5.49} \text{ for BG}$$

&

$$\frac{5.49}{B+4.27} \text{ for MG}$$

Where **B =** the spacing of main girders in metres.

The same Coefficient of dynamic augment (CDA) may be used for calculating the stresses in main girders upto 7.5m effective span, stringers with spans upto 7.5m and also chords of triangulated girders supporting the steel troughing or steel sleepers.

2.4.1.2 For Narrow Gauge Railways of 762mm and 610mm gauges, the Coefficient of Dynamic Augment shall be $\frac{91.5}{91.5+L}$

Where **L** = the loaded length of the span as defined in Clause 2.4.1.1(a).

2.4.2 Railway pipe culverts, arch bridges, concrete slabs and concrete girders.

2.4.2.1 For all gauges

(a) If the depth of fill is less than 900mm, the Coefficient of Dynamic Augment shall be equal to-

$$[2-(d/0.9)] \times \frac{1}{2} \times CDA$$

as obtained from Clause 2.4.1.1(a)

Where, **d** = depth of fill in 'm'.

(b) If the depth of fill is 900mm, the Coefficient of Dynamic Augment shall be half of that specified in clause 2.4.1.1(a) subject to a maximum of 0.5. Where depth of fill exceeds

900mm, the Coefficient of Dynamic Augment shall be uniformly decreased to zero within the next 3 metres.

(c) In case of concrete girders of span of 25m and larger, the CDA shall be as specified in Clause 2.4.1.1. (a)

NOTE:

For spans less than 25m, the CDA shall be computed as per sub-clause (a) or (b) as may be applicable.

(1) *The "depth of fill" is the distance from the underside of the sleeper to the crown of an arch or the top of a slab or a pipe.*

(2) *The above coefficients are applicable to both single and multiple track bridges, subject to Note 3.*

(3) *On multiple track arch bridges of spans exceeding 15m, 2/3rd of the above coefficient shall be used.*

(4) *In case of steel girders with ballasted concrete slab decks, Coefficient of Dynamic Augment for the steel spans should be as specified in Clause 2.4.1.1.*

2.4.3 Footbridges: No allowance need be made for dynamic effects.

2.4.4 Combined Rail and Road Bridges: For combined rail road bridges, the allowance for dynamic effects should be in accordance with Clause 2.3.3.

2.4.5 Trestles (Steel), Iron and Concrete: Allowance for dynamic effects shall be as per Clauses 2.4.1 to 2.4.4 with appropriate loaded length for the worst possible combination of stresses in the member under consideration.

2.4.6 Turntable Girders: All turntable girders shall be designed for a dynamic augment of 10% of the live load with additional allowance, amounting to 100% in all on an axle, which is placed at one end of the turntable.

2.5 FORCES DUE TO CURVATURE AND ECCENTRICITY OF TRACK

2.5.1 For ballasted deck bridges, even on straight alignment, an eccentricity of centre line of track from design alignment upto 100mm shall be considered for the purpose of designs.

2.5.2 Where a track (or tracks) on a bridge is curved, allowance for centrifugal action of the moving load shall be made in designing the member, all tracks on the structure being considered as occupied.

2.5.3 For railway bridges the following loads must be considered:

(a) The extra loads on one girder due to the additional reaction on one rail and to the lateral displacement of the track calculated under the following two conditions:

(i) Live load running at the maximum speed.

(ii) Live load standing with half normal dynamic augment.

(b) The horizontal load due to centrifugal force which may be assumed to act at a height of 1830mm for "25t Loading-2008" for BG, 3000mm for "DFC loading (32.5t axle load)" for BG and 1450mm for MG above rail level is:

$$C = \frac{WV^2}{12.95R} \text{ OR } \left(\frac{WV^2}{127R} \text{ in MKS Units} \right)$$

Where,

C= Horizontal effect in kN/m run (t/m run) of span.

W= Equivalent Distributed live load in t/m run.

V= Maximum speed in km per hour, and

R= Radius of the curve in m.

2.6 TEMPERATURE EFFECT

2.6.1 Where any portion of the structure is not free to expand or contract under

variation of temperature, allowance shall be made for the stresses resulting from this condition. The temperature limit shall be specified by the Engineer.

2.6.2 The coefficient of expansion shall be taken as below:

for steel and reinforced concrete

11.7×10^{-6} per 1^0 C

for plain concrete

10.8×10^{-6} per 1^0 C

2.7 FRICTIONAL RESISTANCE OF EXPANSION BEARINGS

2.7.1 Where the frictional resistance of the expansion bearings has to be taken into account, the following coefficients shall be assumed in calculating the amount of friction in bearings:

For roller bearing	0.03
For sliding bearings of steel on cast iron or steel bearing	0.25
For sliding bearing of steel on ferro bestos	0.20
For sliding bearings of steel on hard copper alloy bearings	0.15
For sliding bearings of PTFE/Elastomeric type	0.10
For concrete over concrete with bitumen layer in between	0.50
For concrete over concrete not intentionally roughened	0.60

2.7.2 For expansion and contraction of the structure, due to variation of temperature under dead load, the friction on one expansion bearing shall be considered as an additional load throughout the chord to which the bearing plates are attached.

2.7.3 In those cases in which the supports are rigid, friction of the bearings corresponding to the dead and live load reaction may be considered to resist the change of length of the chord under load, and may therefore be assumed to be a relief of stress uniform throughout the chord to which the bearing plates are attached.

2.8 LONGITUDINAL FORCES

2.8.1 Where a structure carries railway track, provision as under shall be made for the longitudinal loads arising from any one or more of the following causes:

(a) the tractive effort of the driving wheels of locomotives;

(b) the braking force resulting from the application of the brakes to all braked wheels;

(c) resistance to the movement of the bearings due to change of temperature and deformation of the bridge girder. Roller, PTFE or elastomeric bearings may preferably be provided to minimize the longitudinal force arising on this account.

(d) Forces due to continuation of LWR/CWR over the bridges.

2.8.1.1 Total longitudinal force transferred to sub-structure through any bearing due to causes mentioned in Clause 2.8.1 shall not be more than the limiting resistance at the bearing for the transfer of longitudinal force.

2.8.2 For Railway Bridges, the value of longitudinal force due to either tractive effort or the braking force for a given loaded length shall be obtained from the Appendices IV, IV (a), XXIV and XXVIII.

2.8.2.1 For bridges having simply supported spans, the loaded length shall be taken equal to

(a) The length of one span when considering the effect of longitudinal forces on

(i) the girders

(ii) the stability of abutments

(iii) the stability of piers carrying sliding or elastomeric bearings under one span loaded condition or

(iv) the stability of piers carrying one fixed and one free (roller or PTFE) bearings.

(b) The length of two spans when considering stability of piers carrying fixed or sliding or elastomeric bearings, under the two span loaded conditions. The total longitudinal force shall be considered divided between the two spans in proportion to their lengths.

2.8.2.1.1 In case of continuous span bridges, appropriate loaded length shall be considered which will give the worst effect.

2.8.2.2 No increase shall be made in the longitudinal force for the dynamic effect.

2.8.2.3 The longitudinal forces shall be considered as acting horizontally through the knuckle pins in case of bearings having rocking arrangement or through girder seats in case of sliding, elastomeric or PTFE bearings for the design of bearings and sub-structure.

2.8.2.4.1 For sub-structure having sliding or elastomeric bearings, following percentage of net longitudinal force from the loaded spans after allowing for dispersion as per Clauses 2.8.3.1, 2.8.3.2 and 2.8.3.3 shall be considered for the design:

Abutment	50%
Pier	40%

In case of multi-span bridges, the design of sub-structure shall also be checked for 20% of net longitudinal force transferred from the span adjoining to the spans directly supported by the sub-structure under consideration and considering the directly supported spans as unloaded. However, this force shall not be more than the limiting resistance of the bearings on the sub-structure for the transfer of longitudinal force under unloaded condition.

2.8.2.4.2 For spans having roller or PTFE bearings at one end, the whole of the net longitudinal force after allowing for dispersion as per Clauses 2.8.3.1, 2.8.3.2 and 2.8.3.3 shall be considered to act through the fixed end.

2.8.2.4.3 Forces due to continuation of LWR/CWR – Till such time the forces due to continuation of LWR/CWR on bridges in Indian conditions are finalized, provisions of UIC 774-3R October 2001 edition with up to date modifications should be provisionally used for design and checking of substructure on bridges located in tangent track only with the following parameters.

(a) Actual longitudinal forces prevailing on the bridge as per loading standard / rolling stock to be operated shall be used.

(b) It shall be ensured that the additional stresses in rail as per computations done using provisions of UIC 774-3R do not exceed the values given in table below :

Rail Section	Maximum additional Stresses in Compression	Maximum additional Stressess in Tension
60 Kg 90 UTS Rail	60 N/mm^2	75 N/mm^2
52 Kg 90 UTS Rail	50 N/mm^2	60 N/mm^2

(c) Span and sub structure arrangement shall be such that the various checks on rotation/ deflection specified in UIC 774-3R are satisfied.

(d) Track Resistance in Ballasted Deck Bridges : For track structure minimum 52 kg 90 UTS rails and PRC sleepers at sleeper density 1540 nos/KM with elastic fastenings, the value of track resistance for computations as per UIC 774-3R shall be taken as 25kN per meter of track in unloaded condition and 50 kN per meter of track in loaded condition.

(e) The computations can be done either using graphs or simplified approach or computer program as indicated in UIC 774-3R provided the conditions specified for their adoption are satisfied the computer program shall be validated with methodology given in UIC-774-3R before use.

(f) Ballasted deck bridges without bearings (slabs, box culverts and arches) need not be checked for forces/effects due to continuation of LWR/CWR.

(g) If rail-free fastenings are provided as per provisions of Manual Of Instructions On Long Welded Rails, such that there is no interaction between the rail and the bridge, then there is no need for checking for forces/effects due to continuation of LWR/CWR.

2.8.2.4.4. In case the stipulations given in para 2.8.2.4.3 above are not fulfilled, measures such as provision of suitable expansion joint or non-provision of LWR/CWR on that particular bridge shall be adopted as decided by Principal Chief Engineer of the zonal railway.

2.8.3 Dispersion and distribution of longitudinal forces.

2.8.3.1 In case of bridges having open deck provided with through welded rails, rail-free fastenings and adequate anchorage of welded rails on approaches (by providing adequate density of sleepers, ballast cushion and its consolidation etc., but without any switch expansion joints) the dispersion of longitudinal force through track, away from the loaded length, may be allowed to the extent of 25% of the magnitude of longitudinal force and subject to a minimum of 16t for BG and 12t for MMG or MGML and 10t for MGBL. This shall also apply to bridges having open deck with jointed track with rail-free fastenings or ballasted deck, however without any switch expansion or mitred joints in either case. Where suitably designed elastomeric bearings are provided the aforesaid dispersion may be increased to 35% of the magnitude of longitudinal force.

NOTE: *Length of approach for the above purpose shall be taken as minimum 30m.*

2.8.3.2 The dispersion of longitudinal force indicated in Clause 2.8.3.1 shall not exceed the capacity of track for dispersing the longitudinal force to the approaches nor shall it exceed the capacity of anchored length of the track on the approaches to resist dispersed longitudinal force. This aspect may be given special attention for the stability of track in case of multi-span bridges provided with elastomeric bearings on all spans.

2.8.3.3 In case of multi-span bridges having continuous spans, or flexible supports such as tall or hollow RCC piers or steel trestles, or flexible bearings (elastomeric bearings) on all supports, or any other special features, which are likely, to affect the distribution of longitudinal forces significantly, the dispersion and distribution of longitudinal forces shall be determined by suitable analysis. The analysis shall take into account stiffness and frictional characteristics of various resisting elements viz., supports, bridge girders, bearings, rail-girder fixtures, track on bridge and approaches etc.

2.8.3.4 For the design of new bridges and in case of rebuilding of existing bridges, dispersion of longitudinal force shall not be allowed.

2.8.4 When the bridge carries more than one track. Longitudinal Force (as specified in paras 2.8.1 to 2.8.3 and 2.8.5) shall be considered to act simultaneously on all tracks considered loaded such as to produce the worst effect on the component being designed, multiplied by factor given below.

No. of tracks Considered loaded	Multiplication Factor for Longitudinal Force

1	1.00
2	1.00
3	0.90*
4 or more	0.75*

* Note : Multiplication factor applicable only if the bridge element is common for multiple lines.

2.8.5 When considering seismic forces, only 50% of gross tractive effort/braking force, to be reduced by taking dispersion and distribution of longitudinal forces, shall be considered along with horizontal seismic forces along/across the direction of the traffic.

2.9 RACKING FORCES

2.9.1 Lateral bracings of the loaded deck of railway spans shall be designed to resist, in addition to the wind and centrifugal loads specified above, a lateral load due to racking forces of 5.88 kN/m (600 kg/m) treated as moving load. This lateral load need not be taken into account when calculating stresses in chords or flanges of main girders.

For "DFC loading (32.5t axle load)", the lateral load due to racking forces of 13.72 kN/m(1400 kg/m) be treated as moving load.

2.9.2 In the cases of effective spans upto 20m it is not necessary to calculate wind stresses but, in railway bridges lateral bracings shall be provided designed for a lateral load due to wind and racking forces of 8.82 kN/m (900 kg/m) treated as a moving load in addition to the centrifugal load, if any.

In case of "DFC loading (32.5t axle load)", lateral load due to wind and racking forces of 16.66 kN/m(1700 kg/m) be treated as moving load in addition to the centrifugal load, if any.

2.10 FORCES ON PARAPETS

Railings or parapets shall have a minimum height above the adjacent roadway or footway surface, of 1m less one half the horizontal width of the top rail or top of the parapet. They shall be designed to resist a lateral horizontal force and a vertical force of 1.47 kN/m(150 kg/m) applied simultaneously at the top of the railing or parapet.

2.11 WIND PRESSURE EFFECT

2.11.1 Basic Wind Pressures

2.11.1.1 Wind pressures are expressed in terms of a basic wind pressure 'P' which is an equivalent static pressure in the windward direction.

2.11.1.2 In choosing the appropriate wind velocity for the purpose of determining the basic wind pressure, due consideration shall be given to the degree of exposure appropriate to the locality and also to the local meteorological data.

2.11.1.3 For purposes of design where no meteorological records are available, the Map as given in IS: 875 (Part 3) in conjunction with the Table therein, may be used for determining the basic wind pressures.

2.11.2 The wind pressure specified above shall apply to all loaded or unloaded bridges provided that a bridge shall not be considered to be carrying any live load when the wind pressure at deck level exceeds the following limits:

Broad Gauge bridges	1.47 kN/m^2 (150 kg/m^2)
Metre and Narrow Gauge Bridges	0.98 kN/m^2 (100kg/m^2)
Foot-bridges	0.74 kN/m^2 (75 kg/m^2)

2.11.3 Wind Pressure

2.11.3.1 For Railway and Footbridges: The wind pressure shall be computed from the appropriate basic wind pressure given in Clause 2.11.1 and the exposed area as given below:

(a) For unloaded spans and trestles net exposed area shall be considered as

one and half times the horizontal projected area of the span or the trestle, except for plate girders for which the area of the leeward girder shall be multiplied by the factors shown below and added to the area of the windward girder: -

When the spacing of the leeward girder does not exceed half its depth	0.00
For spacing exceeding half depth and upto full depth	0.25
For spacing exceeding full depth and upto one and half times depth	0.50
For spacing exceeding one and a half times depth and upto twice its depth or more	1.00

(b) For loaded spans the net exposed area shall be computed as the sum of (i) and (ii).

(i) One and half times that portion of the horizontal projected area of the span not covered by the moving load, except for plate girders for which the area of the leeward girders not covered by the moving load shall be multiplied by the factors shown under (a) above and added to the area of the windward girder above or below the moving load, and

(ii) The horizontal projected area of the moving load.

NOTE:

(1) *In the case of railway bridges, the area of the moving load shall be taken as from 600mm above rail level to the top of the highest stock for which the bridge is designed.*

(2) *In the case of footbridges, the height of the moving load is to be taken as 2m throughout the length of the span.*

2.11.4 The wind pressure effect is considered as horizontal force acting in such a direction that resultant stresses in the member under consideration are the maximum. The effects of wind pressure to be considered are as follows:

(a) Lateral effect on the top chords and wind bracing considered as a horizontal girder.

(b) The same effect on the lower chords.

(c) The vertical loads on the main girders due to the overturning effect of the wind on the span and on the live load.

(d) Bending and direct stresses in the members transmitting the wind load from the top to the bottom chords or vice versa.

NOTE: *The members of the main girders should be designed for entire wind load on the top chord being transmitted through the portals. Their sections, however, shall not be less than that required to take the additional vertical load on the leeward girder derived from an overturning moment equal to the total wind load on the fixed structure and train multiplied by the height of the centre of pressure above the plane of the top lateral bracings in the case of deck type spans and of the bottom lateral bracings in the case of through type spans.*

2.12 FORCES AND EFFECTS DUE TO EARTHQUAKE

2.12.1 The following definitions shall apply in seismic design:

(a) **Centre of mass:** The point through which the resultant of masses of a system acts. This corresponds to centre of gravity of the system.

(b) **Centre of Rigidity:** The point through which the resultant of the restoring forces of a system acts.

(c) **Critical Damping:** The damping beyond which the motion will not be oscillatory.

(d) **Damping:** The effect of internal friction, imperfect, elasticity of material, slipping, sliding etc. in reducing the amplitude of vibration

and is expressed as a percentage of critical damping.

(e) **Epicenter:** The geographical point on the surface of earth vertically above the focus of the earthquake.

(f) **Focus:** The originating source of the elastic waves which cause shaking of ground.

(g) **Mode Shape Coefficient:** When a system is vibrating in a normal mode, the amplitude of the masses at any particular instant of time expressed as a ratio of the amplitude of one of the masses is known as mode shape coefficient.

(h) **Normal mode:** A system is said to be vibrating in a normal mode or principal mode when all its masses attain maximum values of displacements simultaneously and also they pass through equilibrium positions simultaneously.

(i) **Basic Horizontal Seismic Coefficient (α_0):** A coefficient assigned to each seismic zone to give the basic design acceleration as a fraction of the acceleration due to gravity.

(j) **Importance Factor (I):** A factor to modify the basic horizontal seismic coefficient depending on the importance of a structure.

(k) **Soil-Foundation System Factor (β):** A factor to modify the basic horizontal seismic coefficient depending upon the soil-foundation system.

(l) **Design Horizontal Seismic Coefficient (α_h):** The horizontal seismic coefficient taken for design. It is expressed as a function of the basic horizontal seismic coefficient (α_0) together with the importance factor (I) and the soil foundation; system factor (β).

2.12.2 Ground motion due to earthquake can be resolved in any three mutually perpendicular directions. The predominant direction of vibration is horizontal. Both horizontal and vertical seismic forces have to be taken into account for design of bridge structures (both super-structure and sub-structure). Horizontal force in each of the two directions shall be considered separately with the vertical force as specified in Clause 2.12.4.5.

2.12.3 Seismic coefficient for different zones

2.12.3.1 For the purpose of determining the seismic forces the country is classified into five zones as shown in Appendix XVIII.

2.12.3.2 Seismic coefficient method shall be used for computing the seismic force. Response spectrum method need not be used for computation of seismic forces in railway bridges.

2.12.3.3 Unless otherwise stated, the basic horizontal seismic coefficient (α_0) in different zones shall be taken as given below: -

Values of Basic Horizontal Seismic Coefficient in Different Zones :-

Zone No.	Basic horizontal seismic coefficient (α_0)
V	0.08
IV	0.05
III	0.04
II	0.02

NOTE:

(1) *For portions of foundations below 30m depth the basic horizontal seismic coefficient may be taken as 0.5 (α_0).*

(2) *For structures situated between ground level and 30m depth below ground, the basic horizontal seismic coefficient may be linearly interpolated between (α_0) and 0.5 (α_0).*

(3) *Ground level shall mean the scoured bed level corresponding to mean annual flood.*

2.12.4 Design Seismic Coefficient

2.12.4.1 The design seismic forces shall be computed taking into consideration the importance of the structure and its soil-foundation system.

2.12.4.2 The design values of horizontal seismic coefficient (α_h) shall be computed by the following expression:

$$\alpha_h = \beta I \alpha_0$$

Where, β = a coefficient depending upon the soil- foundation system (see Clause 2.12.4.3)

I = a coefficient depending upon the importance of the structure (see Clause 2.12.4.4) and

α_0 = Basic horizontal seismic coefficient (see Clause 2.12.3.3)

2.12.4.3 To take into account the soil-foundation system on which the structure is founded, a factor for various cases given in Table as below shall be used.

TABLE

Value of β for different soil-foundation systems (Clause 2.12.4.3)

Type of soil mainly constituting the foundation	Value of β for different soils					
	Piles passing through any soil but resting on soil Type-I	Piles not covered under Col.2	Raft foundation	Combined or isolated RCC footings with the beams	Isolated RCC footings without tie beams or un-reinforced strip foundations	Well foundations
1	2	3	4	5	6	7
Type I Rock or hard soils, well graded gravels and sand gravel mixtures with or without clay binder, and clayey sands poorly graded or sand clay mixtures (GP, GW, SP, SW & SC) having N above 30, where N is the Standard Penetration value.	1.0	-	1.0	1.0	1.0	1.0
Type II Medium soils – All soils with N between 10 and 30 and poorly graded sands or gravely sands with little or no fines (SP) with N>15	1.0	1.0	1.0	1.0	1.2	1.2
Type III Soft soils – all soils other than SP with N<10	1.0	1.2	1.0	1.2	1.5	1.5

2.12.4.4 The Importance factor (I) shall be taken as 1.5 for important bridges and 1.0 for all other bridges. A bridge may be classified as 'Important' if it has a linear waterway of 300m or total waterway of 1000 sq. m. or more. In addition any other bridge not falling in the above category may also be classified as important for the purpose by the Chief Engineer depending on special considerations.

2.12.4.5 The design vertical seismic coefficient α_v may be taken as half of the design horizontal seismic coefficient as indicated in Clause 2.12.4.2.

2.12.5 The bridge as a whole and every part of it shall be designed and constructed to resist stresses produced by seismic effects. For horizontal acceleration the stresses shall be calculated as the effect of force applied horizontally at the centre of mass of the elements of the bridge into which it is conveniently divided for the purpose of design. The forces shall be assumed to come from any horizontal direction.

2.12.5.1 Slab, box and pipe culverts need not be designed for seismic forces.

2.12.5.2 For design of super and sub-structures of bridges in different zones, seismic forces may be considered as below:

Zones II to III	– Seismic forces shall be considered in case of bridges of overall-length more than 60m or spans more than 15m.
Zone IV & V	– Seismic forces shall be considered for all spans

2.12.5.3 Masonry and plain concrete arch bridges with spans more than 12 m shall not be built in the seismic zones IV and V.

2.12.6 Horizontal seismic force due to live load on the bridge shall be ignored when acting in the direction of traffic but when acting in the direction perpendicular to traffic, this is to be considered for 50 per cent of the design live load without impact.

2.12.7 Seismic force to be resisted shall be computed as follows: -

$$\mathbf{F = W_m\,\alpha_h\ (or\ \alpha_v)}$$

Where,

F	=	Seismic force to be resisted.
Wm	=	Weight of mass under consideration ignoring reduction due to buoyancy.
α_h or α_v	=	Design horizontal or vertical seismic coefficient as specified in Clauses 2.12.4.2 and 2.12.4.5.

2.12.8 Modal analysis shall be necessary for the following cases in Zones IV and V:

(a) In the design of bridges of types such as cable stayed bridge, horizontally curved girder bridge, reinforced concrete arch or steel arch bridge, and

(b) When the height of sub-structure from base of foundation to the top of the pier is more than 30m or when the bridge span is more than 120m.

2.12.8.1 In case of important bridges where there is a possibility of amplification of vertical seismic coefficient, Modal Analysis is preferable.

2.12.9 Preferred Seismic Aspects of Bridges Conceptual design suggestions in terms of preferred configuration, superstructure, substructure and ground conditions are given in Table below, along with the non preferred types, for which special design and detailing are required. These considerations shall be followed as much as practically possible and a balance shall be maintained between functional requirements, cost and seismic resistance features.

Seismically preferred and not preferred Aspect of Bridges.

	Seismically preferred	Seismically not preferred
1.0	**Configuration**	
1.1	Straight bridge alignment	Curved bridge alignment
1.2	Normal piers	Skewed piers

1.3	Uniform pier stiffness	Varying pier stiffness
1.4	Uniform span stiffness	Varying span stiffness
1.5	Uniform span mass	Varying span mass
2.0	**Superstructure**	
2.1	a) Simply supported spans b) Integral bridges	Continuous spans
2.2	Short spans	Long spans
2.3	Light Spans	Heavy spans
2.4	No intermediate hinges within span	Intermediate hinges
3.0	**Substructure**	
3.1	Wide seats	Narrow seats
3.2	Multiple column	Single column
4.0	**Ground conditions**	
4.1	Stiff, Stable soil	Unstable soil

2.12.10 Vertical Hold-Down Devices : In Zone IV & V, vertical hold-down devices shall be provided at all supports where resulting vertical seismic force opposes and exceeds 50% of the dead load reaction.

2.12.10.1 Where vertical force U, due to the combined effect of maximum elastic horizontal and vertical seismic forces, opposes and exceeds 50%, but is less than 100%, of the dead load reaction D, the vertical hold-down device shall be designed for a minimum net upward force of 10% of the downward dead load reaction that would be exerted it the span were simply supported.

2.12.10.2 – If the vertical force U, due to the combined effect of maximum horizontal and vertical seismic forces, opposes and exceeds 100% of the dead load reaction D, then the device shall be designed for a net upward force of 1.2 (U-D); however, it shall not be less than 10% of the downward dead load reaction that would be exerted if the span were simply supported.

2.12.11 Horizontal Linkage Elements

Horizontal linkage elements are anti-dislodging devices. Positive horizontal linkage elements (high tensile wire strand ties, cables, and dampers) shall be provided between adjacent section of the superstructure at supports and at expansion joints within a span.

2.12.11.1 The linkage shall be designed for at least the elastic seismic horizontal coefficient times the weight of the lighter of the two connected spans or parts of the structure.

2.12.11.2 If the linkage is at locations where relative deformation are permitted in the design then, sufficient slack must be allowed in the linkage so that linkages start functioning only when the relative design displacement at the linkage is exceeded.

2.12.11.3 When linkages are provided at columns or piers, the linkage of each span may be connected to the column or pier instead of the adjacent span. Alternatively, reactions blocks may be provided as per sub-para 2.12.11.4

2.12.11.4 Reaction blocks (or seismic arrestors) when used as anti-dislodging elements shall be designed for seismic force equal to 1.5 times the elastic seismic coefficient multiplied by tributary weight of spans corresponding to that pier/abutment.

2.12.12 Minimum Seating Width Requirements

The widths of seating *W* (in mm) at supports measured normal to the face of the abutment / pier / pedestal of bearings /

restrained portion of superstructure from the closest end of the girder shall be following :

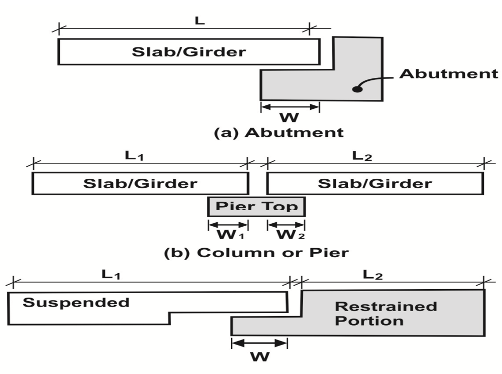
The value specified below

$$W = \begin{cases} 300 + 1.5L + 6Hp \text{ for seismic zones II and III} \\ 500 + 2.5L + 10Hp \text{ for seismic zones IV and V} \end{cases}$$

Where

L = Length (in meters) of the superstructure to the adjacent expansion joint or to the end of superstructure. In case of bearings under suspended spans, it is sum of the lengths of the two adjacent portions of the superstructure. In case of single span bridges, it is equal to the length of the superstructure.

For bearings at abutments, Hp is the average height (in meters) of all columns supporting the superstructure to the next expansion joint. It is equal to zero for single span bridges. For bearings at columns or piers, Hp is the height (in meters) of column or pier. For bearings under suspended spans, Hp is the average height (in meters) of the two adjacent columns or piers. Graphical representation of seating widths is shown in fig.



(c) Suspended Span on Restrained Portion of Superstructure

2.13 ERECTION FORCES AND EFFECTS

2.13.1 The weight of all permanent and temporary material together with all other forces and effects which can operate on any part of the structure during erection shall be taken into account.

2.13.2 Allowance shall be made in the design for stresses set up in any member during erection; such stresses may be different from those, which the member will be subjected to during actual working.

2.14 DERAILMENT LOADS

2.14.1 Derailment loads for "25t Loading-2008" for BG shall be considered for ballasted deck bridges as per Appendix-XXV.

2.14.2 Derailment loads for DFC loading (32.5t axle load) shall be considered for ballasted deck bridges as per Appendix-XXIX.

2.14.3 The loads specified in Clauses 2.14.1 and 2.14.2 shall be applied at the top surface of ballast and may be assumed to disperse at a slope of half horizontal to one vertical.

2.15 LOAD DUE TO PLASSER'S QUICK RELAY SYSTEM (PQRS)

2.15.1 Load due to working of Plasser's Quick Relay System for BG shall be considered for reduced Coefficient of Dynamic Augment for maximum speed of 20 kmph as per Appendix X for the most unfavourable position. The load due to auxiliary track shall be considered separately.

2.15.2 The dispersion of load, as specified in Clause 2.15.1, shall be as per Clause 2.3.4.2.

3.0 RULES FOR ASSESSING THE STRENGTH OF EXISTING RAILWAY BRIDGES

3.1 The preceding rules shall apply to the investigation of the strength of existing bridges except in so far as they are modified in clauses 3.2 to 3.6.

3.2 When it is proposed to increase sanctioned speeds, to remove marshalling restrictions, or to run any different type of stock involving increased loading on an

existing bridge over that already sanctioned, the Engineer shall be responsible for obtaining fresh sanction from the Commissioner of Railway Safety. The Engineer shall certify that such usage will not involve danger to the travelling public.

3.3 Where no rail joint occurs on a span and within 10m on its approaches, the Coefficient of Dynamic Augment (CDA) as calculated in para 2.4.1 and 2.4.2 may be diminished by an amount equal to 0.75/(span in m), subject to a maximum reduction of 20% of the calculated value of CDA for spans of 7.5m and less.

3.3.1 Provided they are certified by the Engineer as being in sound condition and of satisfactory design, and further that the maximum permissible speed will, in no circumstances be exceeded, the Coefficient of Dynamic Augment shall be adopted as below:

(a) CDA laid down in Clauses 2.4.1 and 2.4.2 (diminished) according to Clauses 3.3 where applicable may be multiplied by the factor (Vr/V) where Vr is the permissible speed and V is-

(i) 125 km/h for trains hauled by diesel and electrical locomotives and 80 km/h for steam locomotives on BG.

(ii) 100 km/h for trains hauled by diesel and electric locomotives and 60 km/h for steam locomotives on MG.

NOTE: *Bridges found fit for 125 km/h on BG may be cleared for speeds upto 160 km/h for passenger services with stock specially cleared to run at such speeds.*

3.3.2 The Coefficient of Dynamic Augment shall in no case be taken as less than 0.1.

3.3.3 In cases, where the Coefficient of Dynamic Augment is reduced on the basis of a maximum speed, the transportation branch are to be held responsible that the restriction is rigidly observed. It must also be certified by the responsible authority that the condition of the bridge and of the permanent way warrants this relaxation of Coefficient of Dynamic Augment, which has the effect of increasing the working stresses.

3.4 For the purpose of calculating the longitudinal forces and its dispersion and distribution in case of existing bridges, clause 2.8 shall apply generally. For trains hauled by steam locomotives, the maximum tractive force may be assumed to be 25% of the axle load of the coupled wheels on actual engines under consideration and the maximum braking force to be 20% of the actual braked engine axle loads plus 10% of the other braked axle loads. For trains hauled by diesel or AC or DC locomotives, the maximum tractive force shall be as specified for the locomotive distributed equally amongst the driving axles. The braking force for such locomotives shall be as specified for them distributed equally amongst the braked axles, together with 10% of the weight of the braked trailing axles covering the loaded length, if fitted with vacuum brakes. For trailing axles fitted with air brakes, braking force shall be as specified for them distributed equally amongst the braked axles covering the loaded length, subject to a maximum of 13.4% of the weight of the braked axles.

3.5 For checking adequacy of existing bridges for permitting rolling stock involving higher loads, the bridge shall not be considered to be carrying any live load when the wind pressure at deck level exceeds 100 kg/m^2 ($0.98kN/m^2$).

3.6 For checking the adequacy of Existing Bridges for higher Bridge Loading Standards/higher axle loads, the Bending Moments and shear Forces shall be calculated on the basis of EUDLs specified for different Loading Standards. In case it is found inadequate, calculation shall be done on the basis of actual train axle loads with the help of software "Moving Load" issued by RDSO.

4.0 CRITICAL SPEED

4.1 Critical speed is defined as the speed at which the external forcing

frequency will be equal to one of the natural frequencies of the track-bridge-vehicle system, contributing to vertical response of the bridge.

4.2 Critical speed in the case of steam locomotives and for open web girders only may be calculated by any of the following methods:

(i) by running trains at varying speeds across the bridge and determining the speed giving the maximum deflection.

(ii) by ascertaining the maximum static deflection under live load and applying the following formula: $V = \frac{2C}{\sqrt{d(\frac{W+P}{P})}}$

Where-

V = critical speed in km/h

C = circumference of driving wheels in m.

W = dead load of the span in kN (t) per m

P = equivalent live load in kN (t) per m run of the train on the span, at the position giving maximum Bending Moment, and

d = maximum static deflection in m caused by the live load; and

(iii) by the following approximate formula: - $V = \frac{266}{\sqrt{L}}$

Where,

V = critical speed km/h and

L = effective length of span in m.

4.3 Speed restrictions for open web girders for steam traction in the range of critical speed ± 10 km/h as determined in Clause 4.2 should be avoided.

5.0 Details of old standard loadings for Bridges: -

For Broad Gauge (1676mm), the existing loads are given in table below for Broad Gauge Standard Loading (BGML & BGBL) of 1926, RBG loading of 1975, MBG Loading of 1987 and HM loading of 2000.

(a) Broad Gauge Standard Loading (BGML & BGBL) of 1926: -

- The BGML & BGBL Loadings are of-1926
- The details of loading diagrams, EUDL for BM & Shear Force & Tractive Effort & Braking Force, are given in the appendix given as below: -

Loading diagrams for Broad Gauge Standard Loadings (BGML and BGBL)-1926.	Appendix-VI
EUDL in tonnes on each track and CDA values for Broad Gauge Standard Loadings (BGML and BGBL)-1926.	Appendix-VII
Longitudinal loads in tonnes (without deduction for dispersion) for Broad Gauge Standard Loadings (BGML and BGBL)-1926.	Appendix-VIII

(b) Revised Broad Gauge Loading of-1975: -

- The RBG Loading is of-1975
- The details of loading diagrams, EUDL for BM & Shear Force & Tractive Effort & Braking Force are given in the appendix given as below:

Loading diagrams for Revised Broad Gauge Standard Loading (RBG)-1975.	Appendix-XI
EUDL in tonnes on each track and CDA values for Revised Broad Gauge Standard Loadings (RBG)-1975.	Appendix-XII
Longitudinal loads in tonnes (without deduction of dispersion) for revised Broad Gauge Standard Loading (RBG)-1975	Appendix-XIII

(c) Modified Broad Gauge Loading of-1987:

- The MBG Loading is of-1987.
- The details of loading diagrams, EUDL for BM & Shear Force & Tractive Effort & Braking Force are given in the appendix given as below: -

Loading diagrams for MBG-1987 loading.	Appendix-XIX
EUDL in tonnes on each track and CDA values for MBG-1987 loading.	Appendix-XX & XX(a)
Longitudinal loads in tonnes (without deduction of dispersion) for MBG-1987 loading.	Appendix-XXI

- Details of Derailment loads for ballasted deck bridges for MBG loading are given in Appendix-IX

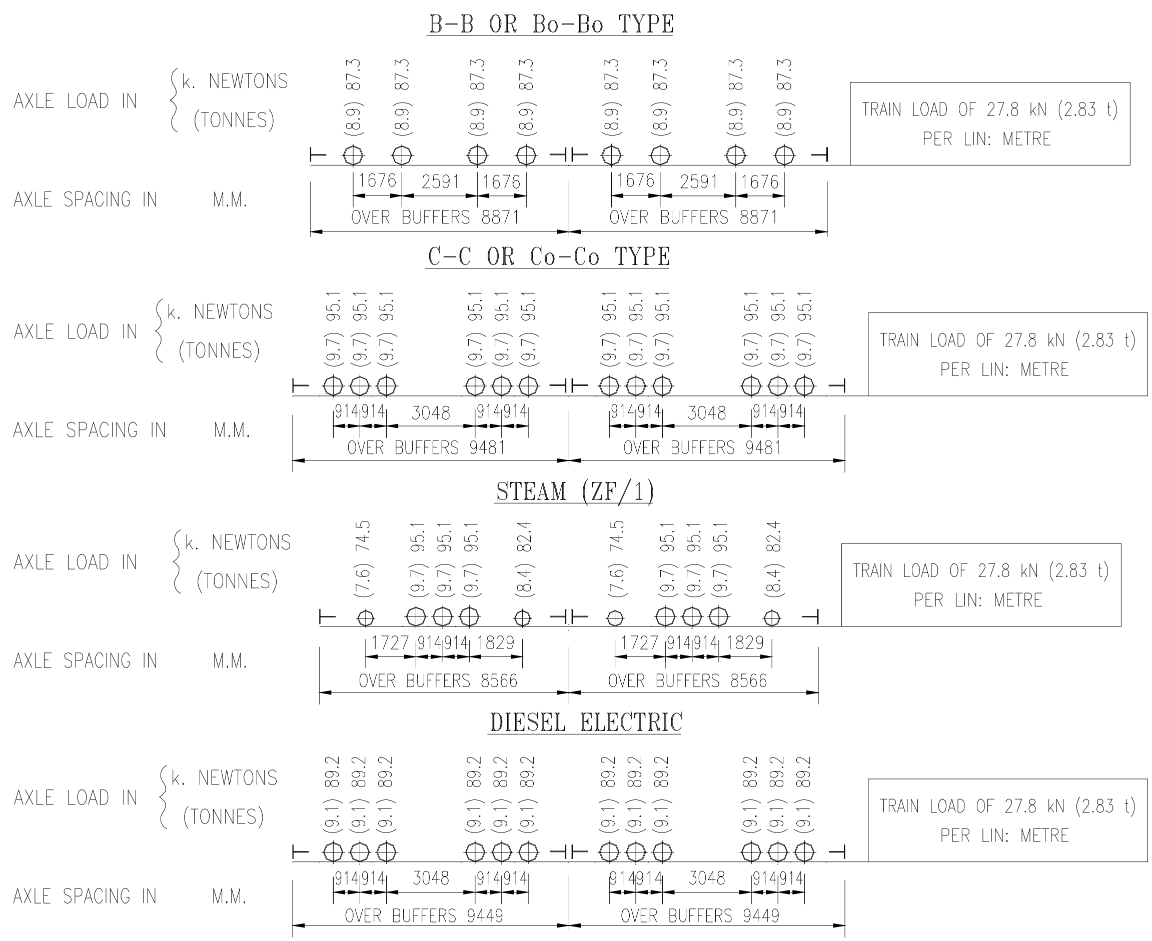
(d) HM Loading: -

- The HM Loading is of-2000.
- The details of loading diagrams, EUDL for BM & Shear Force & Tractive Effort & Braking Force are given in the appendix given as below: -

Loading diagrams for HM loading.	Appendix-XIV
EUDL in tonnes on each track and CDA values for HM loading.	Appendix-XV & XV(a)
Longitudinal loads in tonnes (without deduction of dispersion) for HM loading.	Appendix-XVI

- Details of Derailment loads for ballasted deck bridges for HM loading are given in Appendix-XVII.

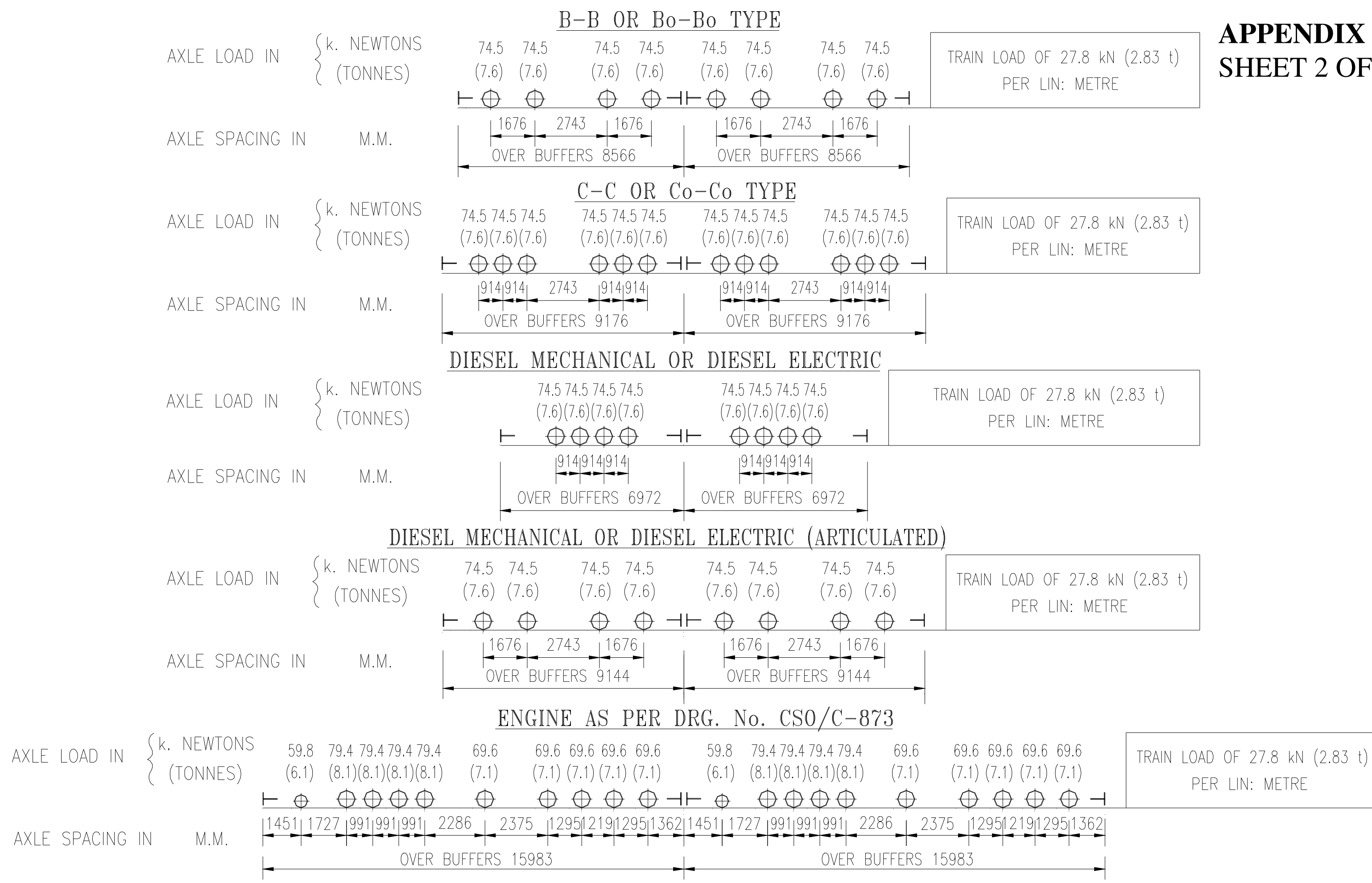
APPENDIX I
SHEET 1 OF 3



762 mm GAUGE - "H" CLASS LOADING

CBS - 2202

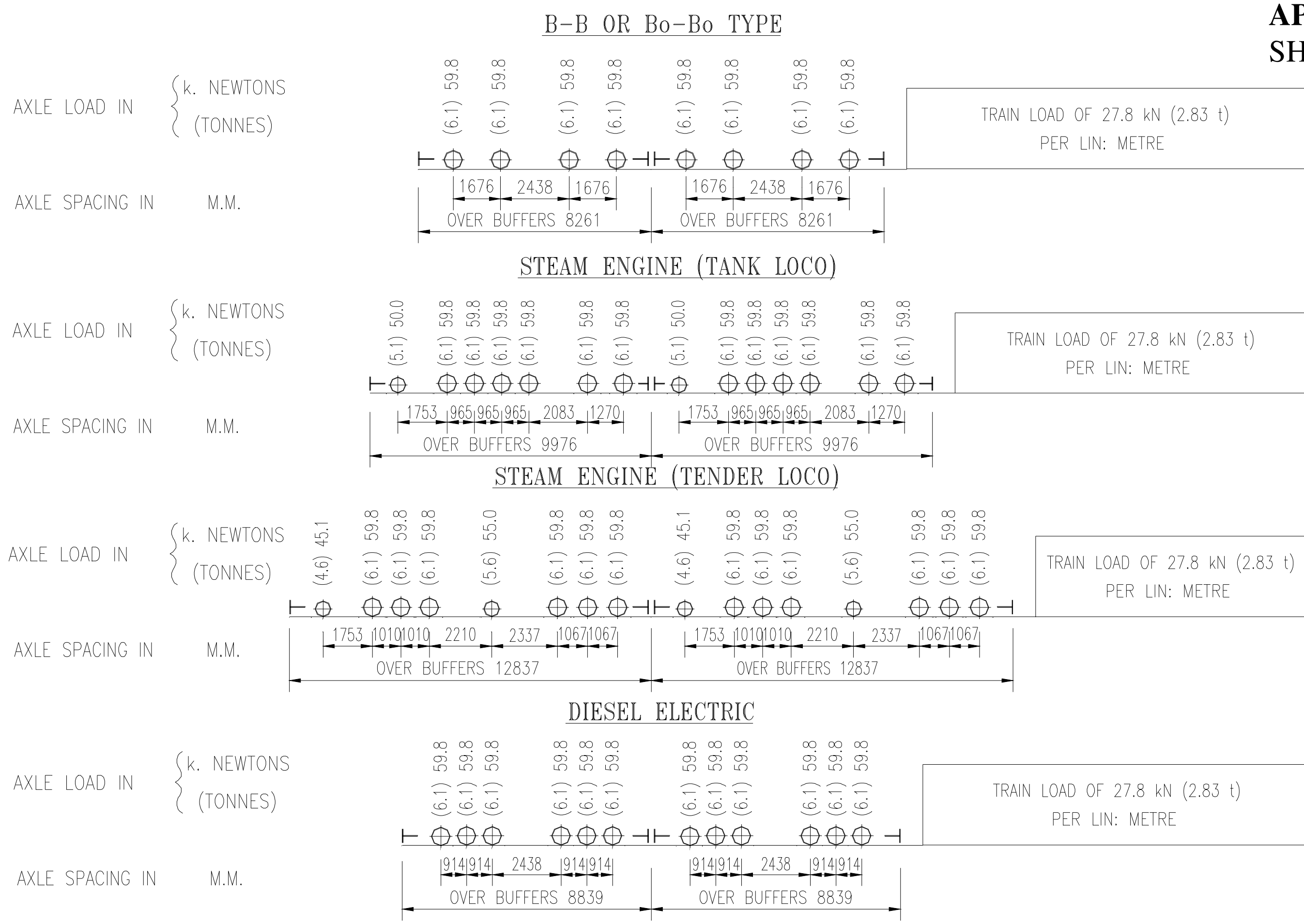
APPENDIX I
SHEET 2 OF 3



762 mm GAUGE - "A" CLASS LOADING

CBS - 2202/1

APPENDIX I
SHEET 3 OF 3



762 mm GAUGE – "B" CLASS LOADING

CBS – 2202/2

762mm GAUGE

Equivalent Uniformly Distributed Loads (EUDL) in kilo Newtons (tonnes) on each track, and Coefficient of Dynamic Augment (CDA) for 762 mm Gauge Bridges

For Bending Moment, L is equal to the effective span in metres. For Shear, L is the loaded length in metres to give the maximum Shear Force in the member under consideration.

NOTE:

(1) *Cross girders – The live load on a cross girder will be equal to half the total load for Bending in a length L, equal to twice the distance over centres of cross girders.*

(2) *L for Coefficient of Dynamic Augment (CDA) shall be as laid down in Clause 2.4.1.*

(3) *When loaded length lies between the values given in the table, the EUDL for Bending Moment and Shear can be interpolated.*

L (m)	Total Load for Bending Moment						Impact Factor CDA= 91.5/(91.5+L)
	H Class loading		A Class loading		B Class loading		
	kN	t	kN	t	kN	t	
1	2	3	4	5	6	7	8
1.0	189.3	19.3	159.8	16.3	119.6	12.2	.989
1.5	189.3	19.3	159.8	16.3	119.6	12.2	.984
2.0	240.3	24.5	205.9	21.0	156.9	16.0	.979
2.5	304.0	31.0	259.9	26.5	186.3	19.0	.973
3.0	338.3	34.5	279.5	28.5	215.7	22.0	.968
3.5	372.7	38.0	299.1	30.5	235.4	24.0	.963
4.0	392.3	40.0	343.2	35.0	250.1	25.5	.958
4.5	416.8	42.5	372.7	38.0	264.8	27.0	.953
5.0	441.3	45.0	397.2	40.5	289.3	29.5	.948
5.5	465.8	47.5	421.7	43.0	333.4	34.0	.943
6.0	485.4	49.5	441.3	45.0	372.7	38.0	.938
6.5	509.9	52.0	456.0	46.5	397.2	40.5	.934
7.0	544.3	55.5	470.7	48.0	416.8	42.5	.929
7.5	568.8	58.0	485.4	49.5	436.4	44.5	.924
8.0	588.4	60.0	505.0	51.5	446.2	45.5	.920
8.5	603.1	61.5	524.7	53.5	456.0	46.5	.915
9.0	617.8	63.0	549.2	56.0	465.8	47.5	.910
9.5	627.6	64.0	578.6	59.0	470.7	48.0	.906
10.0	642.3	65.5	608.0	62.0	475.6	48.5	.901
11.0	681.6	69.5	632.5	64.5	490.3	50.0	.893

APPENDIX II (Contd…)

1	2	3	4	5	6	7	8
12.0	750.2	76.5	657.0	67.0	509.9	52.0	.884
13.0	863.0	88.0	676.7	69.0	539.4	55.0	.876
14.0	931.6	95.0	711.0	72.5	588.4	60.0	.867
15.0	970.9	99.0	784.5	80.0	686.5	70.0	.859
16.0	1029.7	105.0	843.4	86.0	755.1	77.0	.851
17.0	1078.7	110.0	882.6	90.0	784.5	80.0	.843
18.0	1127.8	115.0	921.8	94.0	823.8	84.0	.836
19.0	1176.8	120.0	961.1	98.0	853.2	87.0	.828
20.0	1225.8	125.0	1000.3	102.0	882.6	90.0	.821
21.0	1274.9	130.0	1039.5	106.0	921.8	94.0	.813
22.0	1323.9	135.0	1088.5	111.0	951.2	97.0	.806
23.0	1372.9	140.0	1127.8	115.0	980.7	100.0	.799
24.0	1422.0	145.0	1176.8	120.0	1019.9	104.0	.792
25.0	1471.0	150.0	1225.8	125.0	1049.3	107.0	.785
26.0	1520.0	155.0	1274.9	130.0	1088.5	111.0	.779
27.0	1559.3	159.0	1323.9	135.0	1118.0	114.0	.772
28.0	1598.5	163.0	1363.1	139.0	1157.2	118.0	.766
29.0	1637.7	167.0	1412.2	144.0	1186.6	121.0	.759
30.0	1676.9	171.0	1451.4	148.0	1216.0	124.0	.753
32.0	1755.4	179.0	1539.6	157.0	1284.7	131.0	.741
34.0	1833.8	187.0	1618.1	165.0	1353.3	138.0	.729
36.0	1902.5	194.0	1696.6	173.0	1422.0	145.0	.718
38.0	1971.1	201.0	1775.0	181.0	1490.6	152.0	.707
40.0	2039.8	208.0	1853.5	189.0	1549.5	158.0	.696
42.0	2098.6	214.0	1922.1	196.0	1618.1	165.0	.685
44.0	2167.3	221.0	1980.9	202.0	1686.7	172.0	.675
46.0	2235.9	228.0	2049.6	209.0	1745.6	178.0	.665
48.0	2294.8	234.0	2108.4	215.0	1814.2	185.0	.656
50.0	2353.6	240.0	2177.1	222.0	1873.1	191.0	.647
55.0	2510.5	256.0	2343.8	239.0	2020.2	206.0	.625
60.0	2667.4	272.0	2490.9	254.0	2147.7	219.0	.604
65.0	2775.3	283.0	2638.0	269.0	2275.1	232.0	.585
70.0	2824.3	288.0	2785.1	284.0	2373.2	242.0	.567
75.0	2853.7	291.0	2932.2	299.0	2441.9	249.0	.550

L (m)	Total Load kN (t) for Shear Force H Class loading		A Class loading		B Class loading		Impact Factor CDA= 91.5 / (91.5+L)
	KN	t	KN	t	KN	t	
1	2	3	4	5	6	7	8
1.0	237.3	24.2	189.3	19.3	149.1	15.2	.989
1.5	264.8	27.0	215.7	22.0	166.7	17.0	.984
2.0	308.9	31.5	250.1	25.5	196.1	20.0	.979
2.5	362.8	37.0	294.2	30.0	225.6	23.0	.973
3.0	397.2	40.5	323.6	33.0	250.1	25.5	.968
3.5	421.7	43.0	362.8	37.0	274.6	28.0	.963
4.0	451.1	46.0	392.3	40.0	304.0	31.0	.958
4.5	485.4	49.5	421.7	43.0	323.6	33.0	.953
5.0	505.0	51.5	451.1	46.0	343.2	35.0	.948
5.5	524.7	53.5	475.6	48.5	362.8	37.0	.943
6.0	544.3	55.5	500.1	51.1	382.5	39.0	.938
6.5	568.8	58.0	519.8	53.0	402.1	41.0	.934
7.0	598.2	61.0	539.4	55.0	421.7	43.0	.929
7.5	627.6	64.0	559.0	57.0	441.3	45.0	.924
8.0	657.0	67.0	578.6	59.0	460.9	47.0	.920
8.5	681.6	69.5	603.1	61.5	475.6	48.5	.915
9.0	711.0	72.5	617.8	63.0	495.2	50.5	.910
9.5	740.4	75.5	637.4	65.0	514.8	52.5	.906
10.0	769.8	78.5	657.0	67.0	534.5	54.5	.901
11.0	833.6	85.0	706.1	72.0	573.7	58.5	.893
12.0	897.3	91.5	750.2	76.5	612.9	62.5	.884
13.0	951.2	97.0	794.3	81.0	652.1	66.5	.876
14.0	1010.1	103.0	838.5	85.5	696.3	71.0	.867
15.0	1068.9	109.0	882.6	90.0	735.5	75.0	.859
16.0	1118.0	114.0	941.4	96.0	774.7	79.0	.851
17.0	1176.8	120.0	990.5	101.0	823.8	84.0	.843
18.0	1245.4	127.0	1039.5	106.0	863.0	88.0	.836
19.0	1314.1	134.0	1078.7	110.0	902.2	92.0	.828
20.0	1382.7	141.0	1127.8	115.0	941.4	96.0	.821
21.0	1441.6	147.0	1167.0	119.0	980.7	100.0	.813

APPENDIX II (Contd….)

1	2	3	4	5	6	7	8
22.0	1490.6	152.0	1206.2	123.0	1010.1	103.0	.806
23.0	1529.8	156.0	1255.3	128.0	1039.5	106.0	.799
24.0	1569.1	160.0	1294.5	132.0	1078.7	110.0	.792
25.0	1608.3	164.0	1343.5	137.0	1108.2	113.0	.785
26.0	1657.3	169.0	1382.7	141.0	1147.4	117.0	.779
27.0	1696.6	173.0	1422.0	145.0	1176.8	120.0	.772
28.0	1735.8	177.0	1471.0	150.0	1206.2	123.0	.766
29.0	1784.8	182.0	1510.2	154.0	1235.6	126.0	.759
30.0	1824.0	186.0	1559.3	159.0	1274.9	130.0	.753
32.0	1902.5	194.0	1637.7	167.0	1333.7	136.0	.741
34.0	1971.1	201.0	1726.0	176.0	1402.4	143.0	.729
36.0	2049.6	209.0	1804.4	184.0	1461.2	149.0	.718
38.0	2128.0	217.0	1882.9	192.0	1529.8	156.0	.707
40.0	2196.7	224.0	1951.5	199.0	1588.7	162.0	.696
42.0	2265.3	231.0	2030.0	207.0	1657.3	169.0	.685
44.0	2334.0	238.0	2098.6	214.0	1716.2	175.0	.676
46.0	2402.6	245.0	2167.3	221.0	1765.2	180.0	.665
48.0	2461.5	251.0	2235.9	228.0	1824.0	186.0	.656
50.0	2530.1	258.0	2304.6	235.0	1882.9	192.0	.647
55.0	2687.0	274.0	2461.5	251.0	2030.0	207.0	.625
60.0	2853.7	291.0	2628.2	268.0	2177.1	222.0	.604
65.0	3020.4	308.0	2785.1	284.0	2314.4	236.0	.585
70.0	3177.4	324.0	2942.0	300.0	2451.7	250.0	.567
75.0	3334.3	340.0	3089.1	315.0	2579.1	263.0	.550

APPENDIX III

METRE GAUGE – 1000 mm

Equivalent Uniformly Distributed Loads (EUDL) in Kilo Newtons (Tonnes) For MG Bridges on each track, and Coefficient of Dynamic Augment (CDA)

For Bending Moment, L is equal to the effective span in metres. For Shear Force, L is the loaded length in metres to give the maximum Shear Force in the member under consideration.

The Equivalent Uniformly Distributed Load (EUDL) for Bending Moment (BM), for spans upto 10m, is that uniformly distributed load which produces the BM at the centre of the span equal to the absolute maximum BM developed under the standard loads. For spans above 10m, the EUDL for BM, is that uniformly distributed load which produces the BM at one-sixth of the span equal to the BM developed at that section under the standard loads.

EUDL for Shear Force (SF) is that uniformly distributed load which produces SF at the end of the span equal to the maximum SF developed under the standard loads at that section.

NOTE:

(1) *Cross girders - The live load on a cross girder will be equal to half the total load for bending in a length L, equal to twice the distance over centres of cross girders.*

(2) *L for Coefficient of Dynamic Augment (CDA) shall be as laid down in Clause 2.4.1.*

(3) *When loaded length lies between the values given in the table, the EUDL for Bending Moment and Shear shall be interpolated.*

L (m)	Total Load for Bending Moment								Impact Factor CDA= 0.15+ 8/(6+L)
	MMG Loading- of 1988		ML Standard of 1929		BL Standard of 1929		C Loading of 1929		
	KN	t	KN	t	KN	t	KN	t	
1	2	3	4	5	6	7	8	9	10
1.0	313.8	32.0	258.9	26.4	209.9	21.4	158.9	16.2	1.000
1.5	313.8	32.0	258.9	26.4	209.9	21.4	158.9	16.2	1.000
2.0	313.8	32.0	258.9	26.4	209.9	21.4	170.6	17.4	1.000
2.5	313.8	32.0	276.5	28.2	224.6	22.9	197.1	20.1	1.000
3.0	325.6	33.2	313.8	32.0	252.0	25.7	213.7	22.3	1.000
3.5	378.5	38.6	378.5	38.6	306.9	31.3	255.0	26.0	.992
4.0	428.6	43.7	428.6	43.7	347.2	35.4	283.4	28.9	.950
4.5	467.8	47.7	467.8	47.7	378.5	38.6	304.0	31.0	.912
5.0	501.1	51.1	498.2	50.8	403.1	41.1	331.5	33.8	.877
5.5	541.3	55.2	539.4	55.0	437.4	44.6	357.9	36.5	.846
6.0	581.5	59.3	581.5	59.3	470.7	48.0	381.5	38.9	.817
6.5	611.0	62.3	611.0	62.3	498.2	50.8	401.1	40.9	.790
7.0	644.3	65.7	644.3	65.7	531.5	54.2	423.6	43.7	.765
7.5	676.7	69.0	676.7	69.0	564.9	57.6	450.1	45.9	.743
8.0	713.9	72.8	713.9	72.8	593.3	60.5	472.7	48.2	.721

APPENDIX III (Contd…)

1	2	3	4	5	6	7	8	9	10
8.5	746.3	76.1	746.3	76.1	617.8	63.0	489.4	49.9	.702
9.0	773.7	78.9	773.7	78.9	640.4	65.3	506.0	51.6	.683
9.5	800.2	81.6	800.2	81.6	661.0	67.4	526.6	53.7	.666
10.0	827.7	84.4	827.7	84.4	683.5	69.7	545.2	55.6	.650
11.0	884.6	90.2	884.6	90.2	724.7	73.9	587.4	59.9	.621
12.0	953.2	97.2	953.2	97.2	784.5	80.0	636.5	64.9	.594
13.0	1015.0	103.5	1015.0	103.5	847.3	86.4	684.5	69.8	.571
14.0	1076.8	109.8	1076.8	109.8	903.2	92.1	733.5	74.8	.550
15.0	1137.6	116.0	1137.6	116.0	961.1	98.0	780.6	79.6	.531
16.0	1202.3	122.6	1202.3	122.6	1015.0	103.5	820.8	83.7	.514
17.0	1261.1	128.6	1261.1	128.6	1064.0	108.5	862.0	87.9	.498
18.0	1316.1	134.2	1316.1	134.2	1111.1	113.3	901.2	91.9	.483
19.0	1368.0	139.5	1368.0	139.5	1159.1	118.2	940.5	95.9	.470
20.0	1421.0	144.9	1421.0	144.9	1202.3	122.6	978.7	99.8	.458
21.0	1466.1	149.5	1466.1	149.5	1243.5	126.8	1020.9	104.1	.446
22.0	1518.1	154.8	1518.1	154.8	1288.6	131.4	1063.0	108.4	.436
23.0	1574.9	160.6	1574.9	160.6	1337.6	136.4	1105.2	112.7	.426
24.0	1625.9	165.8	1625.9	165.8	1380.8	140.8	1145.4	116.8	.417
25.0	1676.9	171.0	1676.9	171.0	1426.9	145.5	1189.5	121.3	.408
26.0	1743.6	177.8	1743.6	177.8	1482.8	151.2	1230.7	125.5	.400
27.0	1808.3	184.4	1808.3	184.4	1537.7	156.8	1275.8	130.1	.392
28.0	1869.1	190.6	1869.1	190.6	1588.7	162.0	1318.0	134.4	.385
29.0	1929.0	196.7	1929.0	196.7	1636.7	166.9	1357.2	138.4	.379
30.0	1990.7	203.0	1990.7	203.0	1685.8	171.9	1398.4	142.6	.372
32.0	2103.5	214.5	2103.5	214.5	1781.9	181.7	1490.6	152.0	.361
34.0	2221.2	226.5	2221.2	226.5	1891.7	192.9	1581.8	161.3	.350
36.0	2343.8	239.0	2343.8	239.0	2000.6	204.0	1666.1	169.9	.340
38.0	2466.4	251.5	2466.4	251.5	2102.5	214.4	1749.5	178.4	.332
40.0	2589.0	264.0	2589.0	264.0	2198.7	224.2	1830.9	186.7	.324
42.0	2691.9	274.5	2691.9	274.5	2290.8	233.6	1912.3	195.0	.317
44.0	2799.8	285.5	2799.8	285.5	2383.0	243.0	1994.7	203.4	.310
46.0	2902.8	296.0	2902.8	296.0	2471.3	252.0	2075.1	211.6	.304
48.0	3000.8	306.0	3000.8	306.0	2561.5	261.2	2154.5	219.7	.298
50.0	3098.9	316.0	3098.9	316.0	2650.7	270.3	2232.0	227.6	.293
55.0	3334.3	340.0	3334.3	340.0	2864.5	292.1	2421.3	246.9	.281

APPENDIX III (Contd…)

1	2	3	4	5	6	7	8	9	10
60.0	3624.7	369.6	3559.8	363.0	3068.5	312.9	2615.4	266.7	.271
65.0	3901.2	397.8	3775.6	385.0	3267.6	333.2	2811.6	286.7	.263
70.0	4177.8	426.0	3971.7	405.0	3472.5	354.1	3009.7	306.9	.255
75.0	4452.4	454.0	4182.5	426.5	3664.7	373.7	3205.8	326.9	.249
80.0	4727.0	482.0	4393.4	448.0	3854.0	393.0	3397.0	346.4	.243
85.0	5000.6	509.9	4594.4	468.5	4059.0	413.9	3587.3	365.8	.238
90.0	5274.2	537.8	4786.6	488.1	4252.2	433.6	3780.5	385.5	.233
95.0	5547.8	565.7	4981.8	508.0	4440.5	452.8	3968.8	404.7	.229
100.0	5820.5	593.5	5177.9	528.0	4637.6	472.9	4150.2	423.2	.225
105.0	6092.1	621.2	5374.0	548.0	4823.9	491.9	4341.4	442.7	.222
110.0	6364.7	649.0	5565.3	567.5	5017.1	511.6	4524.8	461.4	.219
115.0	6636.4	676.7	5756.5	587.0	5202.4	530.5	4707.2	480.0	.216
120.0	6908.1	704.4	5952.6	607.0	5384.3	549.1	4908.2	500.5	.213
125.0	7179.7	732.1	6148.8	627.0	5571.2	568.1	5079.8	518.0	.211
130.0	7451.4	759.8	6335.1	646.0	5779.1	589.3	5284.8	538.9	.209

APPENDIX III (Contd…)

L (m)	Total Load for Shear Force								Impact Factor CDA= 0.15+ 8/(6+L)
	MMG Loading-1988		ML Standard of 1929		BL Standard of 1929		C Loading of 1929		
	KN	t	KN	t	KN	t	KN	t	
1	2	3	4	5	6	7	8	9	10
1.0	313.8	32.0	258.9	26.4	209.9	21.4	158.9	16.2	1.000
1.5	313.8	32.0	285.4	29.1	231.4	23.6	188.3	19.2	1.000
2.0	364.8	37.2	343.2	35.0	278.5	28.4	233.4	23.8	1.000
2.5	416.8	42.5	378.5	38.6	306.9	31.3	250.1	25.5	1.000
3.0	452.1	46.1	428.6	43.7	347.2	35.4	283.4	28.9	1.000
3.5	478.6	48.8	478.6	48.8	386.4	39.4	310.9	31.7	.992
4.0	535.5	54.6	514.8	52.5	417.8	42.6	343.2	35.0	.950
4.5	580.6	59.2	567.8	57.9	460.9	47.0	375.6	38.3	.912
5.0	615.9	62.8	614.9	62.7	498.2	50.8	401.1	40.9	.877
5.5	653.1	66.6	653.1	66.6	529.6	54.0	422.7	43.1	.846
6.0	685.5	69.9	685.5	69.9	555.1	56.6	445.2	45.4	.817
6.5	716.9	73.1	716.9	73.1	589.4	60.1	472.7	48.2	.790
7.0	755.1	77.0	755.1	77.0	620.8	63.3	493.3	50.3	.765
7.5	790.4	80.6	790.4	80.6	647.2	66.0	512.9	52.3	.743
8.0	818.9	83.5	818.9	83.5	670.8	68.4	530.5	54.1	.721
8.5	845.4	86.2	845.3	86.2	692.3	70.6	549.2	56.0	.702
9.0	870.9	88.8	870.8	88.8	715.9	73.0	570.7	58.2	.683
9.5	904.2	92.2	904.2	92.2	741.4	75.6	590.4	60.2	.666
10.0	933.6	95.2	933.6	95.2	764.9	78.0	611.9	62.4	.650
11.0	1000.3	102.0	1000.3	102.0	821.8	83.8	658.0	67.1	.621
12.0	1061.1	108.2	1061.1	108.2	878.7	89.6	708.0	72.2	.594
13.0	1123.9	114.6	1123.8	114.6	936.5	95.5	758.1	77.3	.571
14.0	1182.7	120.6	1182.7	120.6	998.3	101.8	805.1	82.1	.550
15.0	1252.4	127.7	1252.3	127.7	1052.3	107.3	850.2	86.7	.531
16.0	1312.2	133.8	1312.1	133.8	1103.2	112.5	893.4	91.1	.514
17.0	1370.0	139.7	1370.0	139.7	1153.3	117.6	936.5	95.5	.498
18.0	1425.9	145.4	1425.9	145.4	1202.3	122.6	979.7	99.9	.483
19.0	1479.8	150.9	1479.8	150.9	1250.3	127.5	1020.9	104.1	.470
20.0	1531.8	156.2	1531.8	156.2	1297.4	132.3	1063.0	108.4	.458
21.0	1582.8	161.4	1582.8	161.4	1341.5	136.3	1104.2	112.6	.446
22.0	1642.7	167.5	1637.7	167.0	1387.6	141.5	1148.4	117.1	.436
23.0	1703.5	173.7	1700.5	173.4	1443.5	147.2	1193.5	121.7	.426

APPENDIX III (Contd…)

1	2	3	4	5	6	7	8	9	10
24.0	1767.2	180.2	1767.2	180.2	1498.5	152.8	1240.5	126.5	.417
25.0	1832.9	186.9	1832.9	186.9	1555.3	158.6	1283.7	130.9	.408
26.0	1896.6	193.4	1896.6	193.4	1608.3	164.0	1325.9	135.2	.400
27.0	1960.3	199.9	1960.3	199.9	1657.3	169.0	1369.0	139.6	.392
28.0	2020.2	206.0	2020.2	206.0	1710.3	174.4	1410.2	143.8	.385
29.0	2081.0	212.2	2081.0	212.2	1763.2	179.8	1461.2	149.0	.379
30.0	2143.7	218.6	2143.7	218.6	1817.2	185.3	1503.4	153.3	.372
32.0	2267.3	231.2	2267.3	231.2	1929.9	196.8	1599.5	163.1	.361
34.0	2394.8	244.2	2394.8	244.2	2035.9	207.6	1687.7	172.1	.350
36.0	2518.3	256.8	2518.3	256.8	2138.8	218.1	1775.0	181.0	.340
38.0	2635.0	268.7	2635.0	268.7	2239.8	228.4	1861.3	189.8	.332
40.0	2747.8	280.2	2747.8	280.2	2337.9	238.4	1946.6	193.5	.324
42.0	2857.7	291.4	2857.7	291.4	2433.0	248.1	2030.0	207.0	.317
44.0	2964.6	302.3	2964.6	302.3	2527.2	257.7	2114.3	215.6	.310
46.0	3069.5	313.0	3069.5	313.0	2619.4	267.1	2196.7	224.0	.304
48.0	3172.5	323.5	3172.5	323.5	2710.6	276.4	2279.1	232.4	.298
50.0	3269.5	333.4	3269.5	333.4	2830.2	288.6	2360.5	240.7	.293
55.0	3538.4	360.8	3509.8	357.9	3020.4	308.0	2562.5	261.3	.281
60.0	3817.9	389.3	3744.2	381.8	3235.2	329.9	2761.6	281.6	.271
65.0	4095.4	417.6	3968.8	404.7	3446.1	351.4	2961.6	302.0	.263
70.0	4372.0	445.8	4191.4	427.4	3654.9	372.7	3157.7	322.0	.255
75.0	4647.5	473.9	4414.0	450.1	3859.9	393.6	3355.8	342.2	.249
80.0	4922.1	501.9	4624.8	471.6	4062.9	414.3	3549.0	361.9	.243
85.0	5196.7	529.9	4831.7	492.7	4265.9	435.0	3742.2	381.6	.238
90.0	5470.3	557.8	5042.6	514.2	4466.9	455.5	3940.3	401.8	.233
95.0	5744.0	585.7	5328.0	543.3	4666.0	475.8	4132.5	421.4	.229
100.0	6016.6	613.5	5444.7	555.2	4865.1	496.1	4328.7	441.4	.225
105.0	6289.2	641.3	5653.5	576.5	5062.2	516.2	4532.6	462.2	.222
110.0	6561.9	669.1	5858.5	597.4	5259.3	536.3	4713.1	480.6	.219
115.0	6834.5	696.9	6057.6	617.7	5455.4	556.3	4905.3	500.2	.216
120.0	7106.2	724.6	6257.6	638.1	5651.6	576.3	5099.5	520.0	.213
125.0	7377.8	752.3	6455.7	658.3	5846.7	596.2	5291.7	539.6	.211
130.0	7649.5	780.0	6656.8	678.8	6041.9	616.1	5481.9	559.0	.209

EUDL for BM and Shear given in this Appendix are not applicable for ballasted deck for spans upto and including 8.0m for which Appendices III (a), III (b), III (c) and III (d), as the case may be, are to be referred.

APPENDIX III (a)

MMG LOADING-1988
METRE GAUGE – 1000 mm

Equivalent Uniformly Distributed Load (EUDL) In Kilo Newtons (tonnes) for cushions of various depth and spans upto and including 8m

For Bending Moment, L is equal to the effective span in metres.

For Shear, L is the loaded length in metres to give the maximum Shear in the member.

NOTE:

(1) *For intermediate values of L and cushions the EUDL shall be arrived at by linear interpolation.*

(2) *The figures given below do not include dynamic effects.*

L (m)	EUDL for Bending Moment						EUDL for Shear					
	Cushion (mm)						Cushion (mm)					
	200		300		600		200		300		600	
	KN	t	KN	t	KN	t	KN	t	KN	t	KN	t
0.5	188	19.2	156	16.0	98	10.0	188	19.2	156	16.0	98	10.0
1.0	251	25.6	235	24.0	188	19.2	251	25.6	235	24.0	188	19.2
1.5	272	27.8	262	26.7	230	23.5	277	28.2	265	27.1	233	23.7
2.0	283	28.8	275	28.0	251	25.6	308	31.4	298	30.3	267	27.3
2.5	289	29.5	283	28.8	264	26.9	367	37.4	355	36.2	317	32.3
3.0	321	32.7	316	32.2	305	31.1	411	41.9	400	40.8	369	37.6
3.5	370	37.7	369	37.6	358	36.6	446	45.6	436	44.5	408	41.6
4.0	416	42.4	412	42.1	403	41.1	488	49.8	476	48.6	441	45.0
4.5	456	46.5	453	46.2	444	45.3	538	54.9	528	53.8	496	50.6
5.0	489	49.9	486	49.6	477	48.6	579	59.0	569	58.1	541	55.2
6.0	572	58.3	569	58.1	563	57.4	651	66.4	642	65.5	616	62.8
7.0	630	64.3	629	64.1	623	63.5	720	73.5	711	72.6	684	69.8
8.0	700	71.4	699	71.3	694	70.8	788	80.4	780	79.6	756	77.2

APPENDIX III (b)

MGML LOADING - 1929
METRE GAUGE – 1000 mm

Equivalent Uniformly Distributed Load (EUDL) in Kilo Newtons (tonnes) for cushions of various depth and spans upto and including 8m

For Bending Moment, L is equal to the effective span in metres.

For Shear, L is the loaded length in metres to give the maximum Shear in the member.

NOTE:

(1) *For intermediate values of L and cushions the EUDL shall be arrived at by linear interpolation.*

(2) *The figures given below do not include dynamic effects.*

L (m)	EUDL for Bending Moment						EUDL for Shear					
	Cushion (mm)						Cushion (mm)					
	200		300		600		200		300		600	
	KN	t	KN	t	KN	t	KN	t	KN	t	KN	t
1.0	207	21.1	194	19.8	155	15.8	207	21.1	194	19.8	155	15.8
1.5	224	22.8	216	22.0	189	19.3	238	24.3	228	23.2	197	20.1
2.0	232	23.7	227	23.1	207	21.1	293	29.9	281	28.7	247	25.2
2.5	263	26.8	262	26.7	257	26.2	336	34.3	327	33.3	295	30.1
3.0	320	32.6	316	32.2	305	31.1	384	39.2	374	38.1	341	34.8
3.5	370	37.7	369	37.6	358	36.5	433	44.2	423	43.1	369	39.7
4.0	415	42.3	412	42.0	403	41.1	479	48.8	469	47.8	438	44.7
4.5	455	46.4	452	46.1	444	45.3	523	53.3	512	52.2	483	49.3
5.0	481	49.0	479	48.8	471	48.0	573	58.4	563	57.4	532	54.2
6.0	571	58.2	569	58.0	563	57.4	650	66.3	641	65.4	616	62.8
7.0	630	64.2	629	64.1	623	63.5	720	73.4	711	72.5	684	69.7
8.0	700	71.4	698	71.2	693	70.7	787	80.3	780	79.5	756	77.1

APPENDIX III(c)

MGBL LOADING - 1929

METRE GAUGE – 1000 mm

Equivalent Uniformly Distributed Load (EUDL) In Kilo Newtons (tonnes) for cushions of various depths and spans upto and including 8m

For Bending Moment, L is equal to the effective span in metres.

For Shear, L is the loaded length in metres to give the maximum Shear in the member.

NOTE:

(1) *For intermediate values of L and cushions the EUDL shall be arrived at by linear interpolation.*

(2) *The figures given below do not include dynamic effects*

L (m)	EUDL for Bending Moment						EUDL for Shear					
	Cushion (mm)						Cushion (mm)					
	200		300		600		200		300		600	
	KN	t	KN	t	KN	t	KN	t	KN	t	KN	t
1.0	168	17.1	157	16.0	126	12.8	167	17.0	157	16.0	126	12.8
1.5	181	18.5	175	17.8	154	15.7	193	19.7	184	18.8	160	16.3
2.0	188	19.2	183	18.7	168	17.1	237	24.2	228	23.3	200	20.4
2.5	213	21.7	212	21.6	209	21.3	274	27.9	265	27.0	239	24.4
3.0	260	26.5	256	26.1	247	25.2	312	31.8	303	30.9	277	28.2
3.5	299	30.5	297	30.3	293	29.9	351	35.8	342	34.9	315	32.1
4.0	336	34.3	334	34.1	328	33.4	388	39.6	380	38.7	355	36.2
4.5	369	37.6	367	37.4	360	36.7	418	42.6	415	42.3	391	39.9
5.0	389	39.7	387	39.5	381	38.9	465	47.4	456	46.5	431	43.9
6.0	463	47.2	461	47.0	456	46.5	527	53.7	520	53.0	499	50.9
7.0	527	53.7	526	53.6	521	53.1	591	60.3	584	59.6	562	57.3
8.0	587	59.9	586	59.8	583	59.4	645	65.8	639	65.2	620	63.2

APPENDIX III (d)

MG 'C' CLASS LOADING - 1929
METRE GAUGE – 1000 mm

Equivalent Uniformly Distributed Load (EUDL) In Kilo Newtons (tonnes) for Bending Moment and Shear Force for cushions of various depth and spans upto and including 8m

For Bending Moment, L is equal to the effective span in metres.

For Shear Force, L is the loaded length in metres to give the maximum Shear Force in the member.

NOTE:

(1) *For intermediate values of L and cushions the EUDL shall be arrived at by linear interpolation.*

(2) *The figures given below do not include dynamic effects.*

L (m)	EUDL for Bending Moment						EUDL for Shear Force					
	cushion (mm)						cushion (mm)					
	200		300		600		200		300		600	
	kN	t	kN	t	kN	t	kN	t	kN	t	kN	t
1.0	127	12.9	119	12.1	95	9.7	127	12.9	119	12.1	95	9.7
1.5	137	14.0	132	13.5	117	11.9	157	16.0	155	15.8	132	13.5
2.0	155	15.8	152	15.5	139	14.2	201	20.5	193	19.7	170	17.3
2.5	166	16.9	165	16.8	164	16.7	225	22.9	218	22.2	199	20.3
3.0	193	19.7	189	19.3	182	18.6	251	25.6	243	24.8	219	22.3
3.5	272	27.7	269	27.4	261	26.6	283	28.9	277	28.2	256	26.1
4.0	275	28.0	268	27.3	267	27.2	310	31.6	303	30.9	282	28.8
4.5	297	30.3	295	30.1	290	29.6	343	35.0	336	34.3	316	32.2
5.0	326	33.2	325	33.1	320	32.6	373	38.0	366	37.3	347	35.4
6.0	376	38.3	375	38.2	371	37.8	422	43.0	416	42.4	398	40.6
7.0	421	42.9	419	42.7	416	42.4	472	48.1	466	47.5	449	45.8
8.0	466	47.5	465	47.4	462	47.1	511	52.1	506	51.6	491	50.1

APPENDIX IV

METRE GAUGE – 1000mm

Maximum Tractive Effort in KN (t) without deduction for dispersion on each track For MG Loading

NOTE: *Where loaded length lies between the values given in the Table, the tractive effort can, with safety, be assumed as that for the longer loaded length.*

Loaded length in (m)	Tractive effort							
	MMG-1988		ML		BL		C	
	KN	t	KN	t	KN	t	KN	t
1	2	3	43 4	5	6	7	8	9
1.0	89.2	9.1	89.2	9.1	72.6	7.4	54.9	5.6
1.5	86.3	8.8	86.3	8.8	70.6	7.2	53.0	5.4
2.0	117.7	12.0	84.3	8.6	68.6	7.0	55.9	5.7
2.5	117.7	12.0	87.3	8.9	71.6	7.3	62.8	6.4
3.0	117.7	12.0	97.1	9.9	77.5	7.9	67.7	6.9
3.5	117.7	12.0	113.8	11.6	92.2	9.4	76.5	7.8
4.0	156.9	16.0	125.5	12.8	102.0	10.4	83.4	8.5
4.5	156.9	16.0	134.4	13.7	108.9	11.1	87.3	8.9
5.0	156.9	16.0	139.3	14.2	112.8	11.5	93.2	9.5
5.5	156.9	16.0	148.1	15.1	119.6	12.2	98.1	10.0
6.0	156.9	16.0	155.9	15.9	126.5	12.9	102.0	10.4
6.5	176.5	18.0	161.8	16.5	130.4	13.3	104.9	10.7
7.0	176.5	18.0	165.7	16.9	136.3	13.9	109.8	11.2
7.5	208.9	21.3	170.6	17.4	142.2	14.5	112.8	11.5
8.0	208.9	21.3	175.5	17.9	146.1	14.9	116.7	11.9
8.5	235.4	24.0	180.4	18.4	149.1	15.2	118.7	12.1
9.0	261.8	26.7	183.4	18.7	152.0	15.5	119.6	12.2
9.5	261.8	26.7	186.3	19.0	154.0	15.7	122.6	12.5
10.0	261.8	26.7	188.3	19.2	155.9	15.9	124.5	12.7
11.0	313.8	32.0	194.2	19.8	158.9	16.2	129.4	13.2
12.0	313.8	32.0	202.0	20.6	166.7	17.0	135.3	13.8
13.0	313.8	32.0	207.9	21.2	173.6	17.7	140.2	14.3
14.0	313.8	32.0	213.8	21.8	179.5	18.3	145.1	14.8
15.0	353.1	36.0	218.7	22.3	184.4	18.8	150.0	15.3
16.0	365.8	37.3	223.6	22.8	189.3	19.3	153.0	15.6
17.0	418.8	42.7	228.5	23.3	192.2	19.6	155.9	15.9
18.0	418.8	42.7	231.4	23.6	195.2	19.9	157.9	16.1
19.0	470.7	48.0	233.4	23.8	198.1	20.2	160.8	16.4
20.0	470.7	48.0	235.4	24.0	199.1	20.3	162.8	16.6
21.0	470.7	48.0	237.3	24.2	201.0	20.5	164.8	16.8

APPENDIX IV (Contd…)

1	2	3	4	5	6	7	8	9
22.0	470.7	48.0	239.3	24.4	203.0	20.7	167.7	17.1
23.0	470.7	48.0	241.2	24.6	205.0	20.9	169.7	17.3
24.0	522.7	53.3	243.2	24.8	206.9	21.1	171.6	17.5
25.0	522.7	53.3	243.2	24.8	206.9	21.1	171.6	17.5
26.0	575.7	58.7	243.2	24.8	206.9	21.1	171.6	17.5
27.0	627.6	64.0	243.2	24.8	206.9	21.1	171.6	17.5
28.0	627.6	64.0	243.2	24.8	206.9	21.1	171.6	17.5
29.0	627.6	64.0	243.2	24.8	206.9	21.1	171.6	17.5
30.0	627.6	64.0	243.2	24.8	206.9	21.1	171.6	17.5
32.0	627.6	64.0	243.2	24.8	206.9	21.1	171.6	17.5
34.0	627.6	64.0	243.2	24.8	206.9	21.1	171.6	17.5
36.0	627.6	64.0	243.2	24.8	206.9	21.1	171.6	17.5
38.0	627.6	64.0	243.2	24.8	206.9	21.1	171.6	17.5
40.0	627.6	64.0	243.2	24.8	206.9	21.1	171.6	17.5
42.0	627.6	64.0	243.2	24.8	206.9	21.1	171.6	17.5
44.0	627.6	64.0	243.2	24.8	206.9	21.1	171.6	17.5
46.0	627.6	64.0	243.2	24.8	206.9	21.1	171.6	17.5
48.0	627.6	64.0	243.2	24.8	206.9	21.1	171.6	17.5
50.0	627.6	64.0	243.2	24.8	206.9	21.1	171.6	17.5
55.0	627.6	64.0	243.2	24.8	206.9	21.1	171.6	17.5
60.0	627.6	64.0	243.2	24.8	206.9	21.1	171.6	17.5
65.0	627.6	64.0	243.2	24.8	206.9	21.1	171.6	17.5
70.0	627.6	64.0	243.2	24.8	206.9	21.1	171.6	17.5
75.0	627.6	64.0	243.2	24.8	206.9	21.1	171.6	17.5
80.0	627.6	64.0	243.2	24.8	206.9	21.1	171.6	17.5
85.0	627.6	64.0	243.2	24.8	206.9	21.1	171.6	17.5
90.0	627.6	64.0	243.2	24.8	206.9	21.1	171.6	17.5
95.0	627.6	64.0	243.2	24.8	206.9	21.1	171.6	17.5
100.0	627.6	64.0	243.2	24.8	206.9	21.1	171.6	17.5
105.0	627.6	64.0	243.2	24.8	206.9	21.1	171.6	17.5
110.0	627.6	64.0	243.2	24.8	206.9	21.1	171.6	17.5
115.0	627.6	64.0	243.2	24.8	206.9	21.1	171.6	17.5
120.0	627.6	64.0	243.2	24.8	206.9	21.1	171.6	17.5
125.0	627.6	64.0	243.2	24.8	206.9	21.1	171.6	17.5
130.0	627.6	64.0	243.2	24.8	206.9	21.1	171.6	17.5

APPENDIX IV (a)

METRE GAUGE – 1000 mm
Maximum Braking Force in kN(t) without deduction for dispersion on each track
For MG Loading

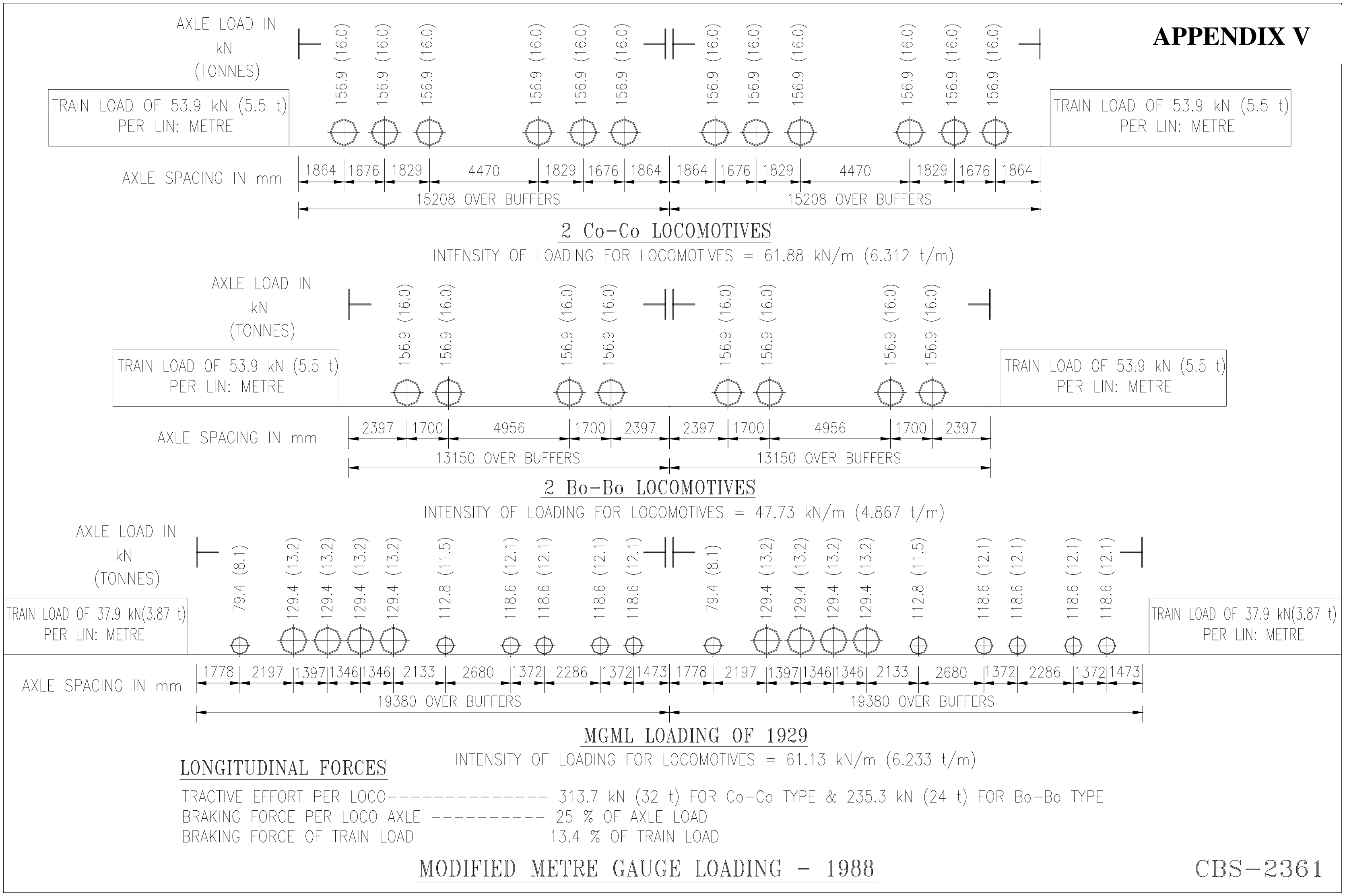
NOTE: *Where the loaded length lies between the values given in the Table, the braking force can, with safety, be assumed as that for longer loaded length.*

Loaded length (m)	Braking Force							
	MMG-1988		ML		BL		C	
	KN	t	KN	t	KN	t	KN	t
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
1.0	56.9	5.8	56.9	5.8	46.1	4.7	34.3	3.5
1.5	55.9	5.7	55.9	5.7	45.1	4.6	34.3	3.5
2.0	78.4	8.0	54.9	5.6	45.1	4.6	36.3	3.7
2.5	78.4	8.0	58.8	6.0	48.1	4.9	42.2	4.3
3.0	78.4	8.0	65.7	6.7	53.0	5.4	46.1	4.7
3.5	78.4	8.0	78.5	8.0	63.7	6.5	53.0	5.4
4.0	117.7	12.0	88.3	9.0	71.6	7.3	58.8	6.0
4.5	117.7	12.0	95.1	9.7	77.5	7.9	61.8	6.3
5.0	117.7	12.0	101.0	10.3	81.4	8.3	67.7	6.9
5.5	118.7	12.1	108.9	11.1	88.3	9.0	71.6	7.3
6.0	122.6	12.5	115.7	11.8	94.1	9.6	76.5	7.8
6.5	125.5	12.8	121.6	12.4	98.1	10.0	79.4	8.1
7.0	129.4	13.2	126.5	12.9	104.0	10.6	84.3	8.6
7.5	156.9	16.0	131.4	13.4	109.8	11.2	87.3	8.9
8.0	156.9	16.0	137.3	14.0	114.7	11.7	91.2	9.3
8.5	156.9	16.0	143.2	14.6	118.7	12.1	94.1	9.6
9.0	196.1	20.0	147.1	15.0	121.6	12.4	96.1	9.8
9.5	196.1	20.0	151.0	15.4	124.5	12.7	99.0	10.1
10.0	196.1	20.0	154.9	15.8	127.5	13.0	102.0	10.4
11.0	235.4	24.0	162.8	16.6	138.4	13.6	107.9	11.0
12.0	235.4	24.0	172.6	17.6	142.2	14.5	115.7	11.8
13.0	235.4	24.0	181.4	18.5	151.0	15.4	122.6	12.5
14.0	240.3	24.5	189.3	19.3	158.9	16.2	129.4	13.2
15.0	247.1	25.2	197.1	20.1	166.7	17.0	135.3	13.8
16.0	274.6	28.0	205.9	21.0	173.6	17.7	140.2	14.3
17.0	313.8	32.0	212.8	21.7	179.5	18.3	145.1	14.8
18.0	313.8	32.0	218.7	22.3	185.3	18.9	150.0	15.3
19.0	353.0	36.0	224.6	22.9	190.2	19.4	154.0	15.7
20.0	353.0	36.0	229.5	23.4	194.2	19.8	157.9	16.1
21.0	356.0	36.3	234.4	23.9	198.1	20.2	162.8	16.6

APPENDIX IV (a) (Contd…)

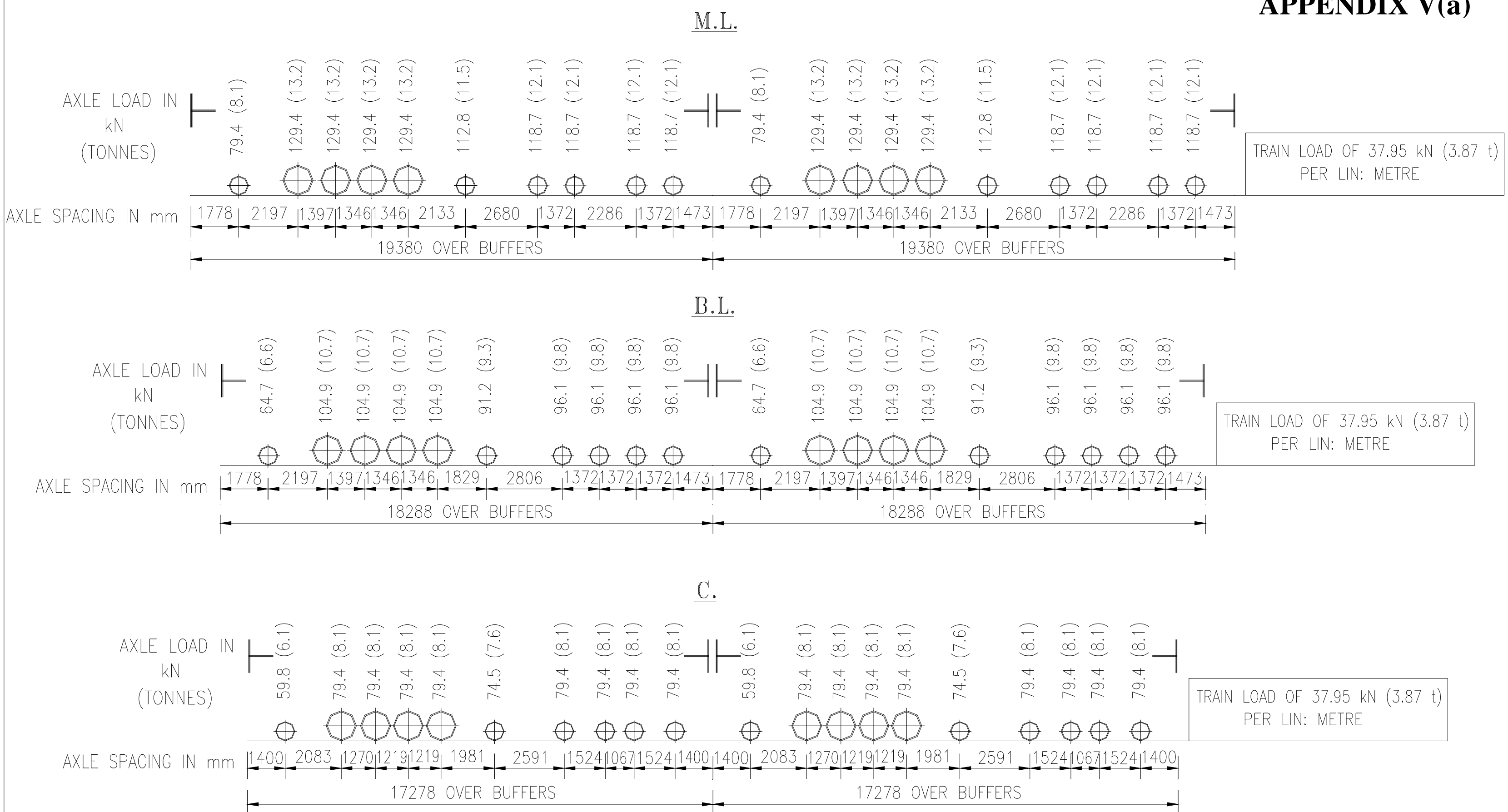
1	2	3	4	5	6	7	8	9
22.0	362.8	37.0	239.3	24.4	203.0	20.7	167.7	17.1
23.0	370.7	37.8	245.2	25.0	207.9	21.2	171.6	17.5
24.0	392.3	40.0	250.1	25.5	211.8	21.6	176.5	18.0
25.0	392.3	40.0	255.0	26.0	216.7	22.1	180.4	18.4
26.0	431.5	44.0	260.9	26.6	222.6	22.7	184.4	18.8
27.0	470.7	48.0	267.7	27.3	227.5	23.2	189.3	19.3
28.0	470.7	48.0	273.6	27.9	232.4	23.7	193.2	19.7
29.0	473.7	48.3	278.5	28.4	236.3	24.1	196.1	20.0
30.0	481.5	49.1	284.4	29.0	240.3	24.5	200.1	20.4
32.0	495.2	50.5	294.2	30.0	249.1	25.4	207.9	21.2
34.0	509.9	52.0	303.0	30.9	257.9	26.3	215.7	22.0
36.0	524.6	53.5	313.8	32.0	267.7	27.3	222.6	22.7
38.0	539.4	55.0	322.6	32.9	275.6	28.1	229.5	23.4
40.0	553.1	56.4	332.4	33.9	281.5	28.7	234.4	23.9
42.0	567.8	57.9	338.3	34.5	288.3	29.4	240.3	24.5
44.0	582.5	59.4	345.2	35.2	293.2	29.9	246.1	25.1
46.0	596.2	60.8	351.1	35.8	299.1	30.5	251.1	25.6
48.0	611.0	62.3	356.0	36.3	304.0	31.0	256.0	26.1
50.0	625.7	63.8	360.9	36.8	308.9	31.5	259.9	26.5
55.0	661.9	67.5	371.7	37.9	318.7	32.5	269.7	27.5
60.0	698.2	71.2	380.5	38.8	328.5	33.5	279.5	28.5
65.0	734.5	74.9	387.4	39.5	335.4	34.2	288.3	29.4
70.0	769.8	78.5	392.3	40.0	343.2	35.0	297.1	30.3
75.0	806.1	82.8	398.1	40.6	349.1	35.6	306..0	31.2
80.0	842.4	85.9	404.0	41.2	355.0	36.2	312.8	31.9
85.0	878.7	89.6	408.9	41.7	360.9	36.8	319.7	32.6
90.0	915.0	93.3	412.9	42.1	366.8	37.4	325.6	33.2
95.0	951.2	97.0	415.8	42.4	370.7	37.8	331.5	33.8
100.0	987.5	100.7	419.7	42.8	375.6	38.3	336.4	34.3
105.0	1022.8	104.3	423.6	43.2	380.5	38.8	342.3	34.9
110.0	1059.1	108.0	426.6	43.5	384.4	39.2	347.2	35.4
115.0	1095.4	111.7	429.5	43.8	388.3	39.6	352.1	35.9
120.0	1131.7	115.4	433.5	44.2	392.3	40.0	357.0	36.4
125.0	1168.0	119.1	436.4	44.5	395.2	40.3	360.9	36.8
130.0	1204.3	122.8	439.3	44.8	400.1	40.8	366.8	37.4

APPENDIX V



AXLE LOAD IN kN (TONNES)
156.9 (16.0)
TRAIN LOAD OF 53.9 kN (5.5 t) PER LIN: METRE
AXLE SPACING IN mm
1864 | 1676 | 1829 | 4470 | 1829 | 1676 | 1864 | 1864 | 1676 | 1829 | 4470 | 1829 | 1676 | 1864
15208 OVER BUFFERS
2 Co-Co LOCOMOTIVES
INTENSITY OF LOADING FOR LOCOMOTIVES = 61.88 kN/m (6.312 t/m)
AXLE LOAD IN kN (TONNES)
156.9 (16.0)
TRAIN LOAD OF 53.9 kN (5.5 t) PER LIN: METRE
AXLE SPACING IN mm
2397 | 1700 | 4956 | 1700 | 2397 | 2397 | 1700 | 4956 | 1700 | 2397
13150 OVER BUFFERS
2 Bo-Bo LOCOMOTIVES
INTENSITY OF LOADING FOR LOCOMOTIVES = 47.73 kN/m (4.867 t/m)
AXLE LOAD IN kN (TONNES)
79.4 (8.1)
129.4 (13.2)
112.8 (11.5)
118.6 (12.1)
TRAIN LOAD OF 37.9 kN(3.87 t) PER LIN: METRE
AXLE SPACING IN mm
1778 | 2197 | 1397 | 1346 | 1346 | 2133 | 2680 | 1372 | 2286 | 1372 | 1473 | 1778 | 2197 | 1397 | 1346 | 1346 | 2133 | 2680 | 1372 | 2286 | 1372 | 1473
19380 OVER BUFFERS
MGML LOADING OF 1929
INTENSITY OF LOADING FOR LOCOMOTIVES = 61.13 kN/m (6.233 t/m)
LONGITUDINAL FORCES
TRACTIVE EFFORT PER LOCO--------------- 313.7 kN (32 t) FOR Co-Co TYPE & 235.3 kN (24 t) FOR Bo-Bo TYPE
BRAKING FORCE PER LOCO AXLE ----------- 25 % OF AXLE LOAD
BRAKING FORCE OF TRAIN LOAD ----------- 13.4 % OF TRAIN LOAD
MODIFIED METRE GAUGE LOADING - 1988
CBS-2361

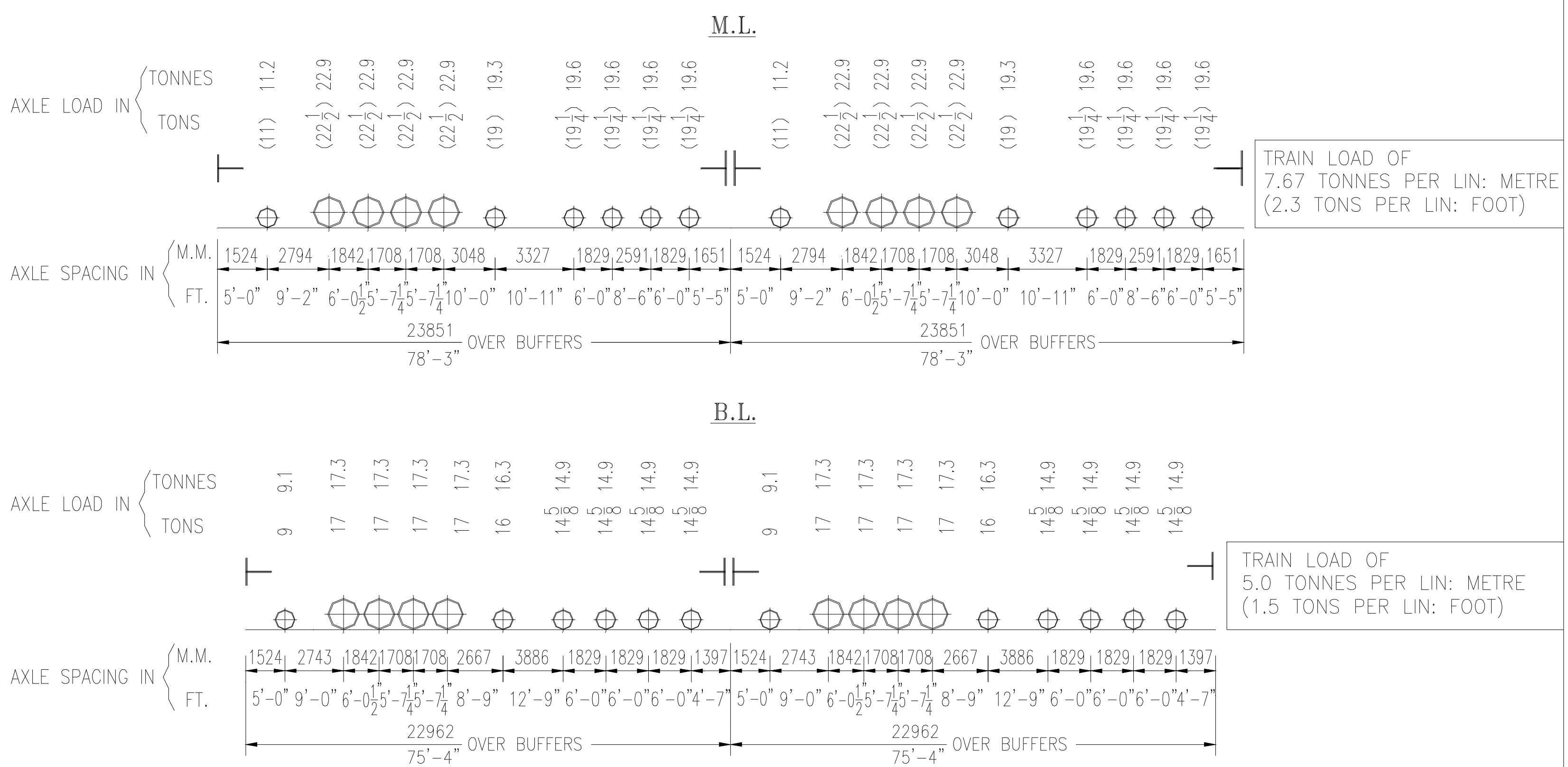
APPENDIX V(a)



METRE GAUGE STANDARD LOADINGS OF 1929

CBS – 2361/1

APPENDIX VI



BROAD GAUGE STANDARD LOADINGS OF 1926

PREPARED BY MOHD. AZHAR/JE-I
CHECKED BY S.K.SINGH/ADE/B&S/SB-II

APPENDIX-VII

BROAD GAUGE-1676 mm (5' 6")

Equivalent Uniformly Distributed Loads (EUDL) in tonnes on each track, and Impact Factors for BG Bridges for Broad Gauge Standard Loadings (BGML and BGBL) - 1926

For Bending Moment, L is equal to the effective span in metres. For Shear Force, L is the loaded length in metres to give the maximum Shear in the member under consideration.

NOTE: *Cross girders – The live load on a cross girder will be equal to half the total load for bending in a length L, equal to twice the distance over centres of cross girders, increased by the impact factor for the length L, as defined above.*

L (m)	Total load (tonnes) for Bending Moment		Total load (tonnes) for Shear		Impact Factor CDA= 20/(14+L)
	ML standard of 1926	BL standard of 1926	ML standard of 1926	BL standard of 1926	
1	2	3	4	5	6
1.0	45.8	34.6	45.8	34.6	1.000
1.5	45.8	34.6	45.8	34.6	1.000
2.0	45.8	34.6	52.4	39.6	1.000
2.5	45.8	34.6	60.4	45.5	1.000
3.0	46.9	35.4	65.5	49.5	1.000
3.5	52.4	39.6	70.3	53.2	1.000
4.0	59.2	44.8	78.8	59.4	1.000
4.5	67.9	51.4	85.2	64.4	1.000
5.0	74.8	56.7	90.3	68.3	1.000
5.5	80.6	60.9	96.7	73.2	1.000
6.0	85.2	64.4	104.9	78.6	1.000
6.5	89.3	67.5	110.2	83.2	0.976
7.0	95.2	71.5	115.2	87.1	0.952
7.5	100.7	75.8	119.8	90.6	0.931
8.0	105.6	79.7	123.9	93.5	0.909
8.5	110.2	82.9	128.6	97.2	0.889
9.0	114.0	86.2	132.4	101.4	0.870
9.5	117.6	90.8	136.7	105.0	0.851
10.0	121.0	94.1	140.6	108.3	0.833
11.0	133.6	102.5	148.3	114.0	0.800
12.0	140.9	108.4	155.7	119.1	0.769
13.0	147.2	113.4	163.7	125.4	0.741
14.0	152.7	117.2	172.0	131.6	0.714
15.0	160.6	123.2	180.6	138.2	0.691

L (m)	Total load (tonnes) for Bending Moment		Total load (tonnes) for Shear		Impact Factor CDA= 20/(14+L)
	ML standard of 1926	BL standard of 1926	ML standard of 1926	BL standard of 1926	
16.0	168.8	130.2	188.1	144.8	0.667
17.0	177.0	137.1	196.8	151.6	0.645
18.0	185.9	143.8	205.0	159.0	0.625
19.0	193.9	150.8	214.1	166.0	0.606
20.0	202.7	158.0	222.4	172.6	0.588
21.0	211.1	164.9	230.5	179.1	0.571
22.0	218.7	169.8	238.7	185.5	0.556
23.0	225.6	175.8	246.6	191.6	0.541
24.0	232.9	181.8	254.8	197.7	0.526
25.0	241.0	188.0	262.7	203.7	0.513
26.0	249.5	193.5	270.7	209.7	0.500
27.0	256.0	198.8	278.9	215.8	0.488
28.0	264.0	205.2	286.6	223.0	0.476
29.0	271.0	211.8	294.4	230.2	0.465
30.0	280.0	216.5	302.3	237.5	0.455
32.0	294.9	230.0	320.0	251.8	0.435
34.0	309.5	243.5	337.5	265.2	0.417
36.0	327.0	257.7	354.2	278.0	0.400
38.0	342.3	270.0	371.2	291.2	0.385
40.0	359.0	282.0	387.7	304.8	0.370
42.0	375.0	295.0	404.6	318.6	0.357
44.0	391.0	308.5	421.8	331.6	0.345
46.0	408.0	322.2	438.4	344.8	0.333
48.0	424.0	334.5	454.9	357.6	0.323
50.0	438.0	347.0	471.3	370.2	0.313
55.0	477.5	376.5	512.2	401.0	0.290
60.0	514.8	405.2	552.8	431.0	0.270
65.0	544.0	433.5	591.6	460.0	0.253
70.0	591.8	461.0	632.2	488.2	0.238
75.0	628.0	486.5	672.0	515.4	0.225
80.0	667.0	513.0	710.9	543.8	0.213
85.0	703.5	539.0	750.4	570.8	0.202
90.0	742.0	568.0	789.8	597.8	0.192
95.0	780.0	591.6	827.8	624.6	0.183
100.0	820.0	616.0	868.6	651.2	0.175

L (m)	Total load (tonnes) for Bending Moment		Total load (tonnes) for Shear		Impact Factor CDA= 20/(14+L)
	ML standard of 1926	BL standard of 1926	ML standard of 1926	BL standard of 1926	
105.0	858.0	642.5	906.2	677.2	0.168
110.0	897.0	668.5	945.6	704.2	0.161
115.0	935.0	694.5	984.8	730.2	0.155
120.0	973.0	719.5	1025.3	756.4	0.149
125.0	1010.0	745.0	1072.4	782.4	0.144
130.0	1048.5	770.0	1113.3	880.4	0.139

APPENDIX-VIII

BROAD GAUGE-1676 mm (5’ 6”)

Longitudinal Loads (Without Deduction For Dispersion) for Broad Gauge Standard Loadings (BGML and BGBL) –1926

L (m)	Tractive Effort (tonnes)		Braking Force (tonnes)	
	ML standard of 1926	BL standard of 1926	ML standard of 1926	BL standard of 1926
1	2	3	4	5
1.0	15.7	11.8	11.3	8.6
1.5	15.4	11.6	11.2	8.5
2.0	15.1	11.5	11.1	8.4
2.5	14.9	11.2	11.0	8.3
3.0	15.0	11.3	11.2	8.4
3.5	16.5	12.5	12.4	9.3
4.0	18.4	13.9	13.9	10.5
4.5	20.7	15.7	15.7	11.9
5.0	22.4	17.0	17.2	13.0
5.5	23.8	18.0	18.4	13.9
6.0	24.8	18.7	19.3	14.6
6.5	25.6	19.4	20.0	15.1
7.0	26.9	20.2	21.2	15.9
7.5	28.2	21.1	22.2	16.7
8.0	29.1	21.9	23.2	17.5
8.5	29.8	22.5	23.9	18.0
9.0	30.4	23.0	24.5	18.5
9.5	30.9	23.9	25.0	19.3
10.0	31.5	24.5	25.7	20.0
11.0	33.8	25.9	27.9	21.4
12.0	34.8	26.8	28.9	22.1
13.0	35.5	27.3	29.8	22.9
14.0	35.9	27.5	30.4	23.3
15.0	36.8	28.2	31.6	24.3
16.0	37.8	29.2	32.7	25.3
17.0	38.8	30.0	33.9	26.2
18.0	39.8	30.8	35.2	27.2
19.0	40.5	31.5	36.0	28.0
20.0	41.6	32.4	37.4	29.1
21.0	42.4	33.1	38.4	30.0
22.0	43.1	33.5	39.3	30.4
1	2	3	4	5
23.0	43.5	33.9	39.9	31.1
24.0	44.0	34.4	40.8	31.8
25.0	44.8	35.0	41.6	32.5
26.0	45.5	35.2	42.7	33.1
27.0	45.8	35.6	43.2	33.6
28.0	46.5	36.1	44.2	34.3
29.0	46.9	36.6	44.7	34.9
30.0	47.6	36.8	45.7	35.3
32.0	47.6	36.8	47.2	36.8
34.0	47.6	36.8	48.7	38.2
36.0	47.6	36.8	50.0	39.4
38.0	47.6	36.8	51.4	40.5
40.0	47.6	36.8	53.1	41.7
42.0	47.6	36.8	54.4	42.8
44.0	47.6	36.8	55.5	43.8
46.0	47.6	36.8	57.1	45.1
48.0	47.6	36.8	58.5	46.2
50.0	47.6	36.8	59.1	46.8
55.0	47.6	36.8	62.1	48.9
60.0	47.6	36.8	64.4	50.7
65.0	47.6	36.8	67.0	52.5
70.0	47.6	36.8	69.2	53.9
75.0	47.6	36.8	71.2	55.0
80.0	47.6	36.8	73.4	56.4
85.0	47.6	36.8	75.3	57.7
90.0	47.6	36.8	77.2	59.1
95.0	47.6	36.8	78.8	59.8
100.0	47.6	36.8	81.2	61.0
105.0	47.6	36.8	83.2	62.3
110.0	47.6	36.8	85.2	63.5
115.0	47.6	36.8	87.0	64.8
120.0	47.6	36.8	88.5	65.5
125.0	47.6	36.8	89.9	66.3
130.0	47.6	36.8	91.2	67.0

APPENDIX IX

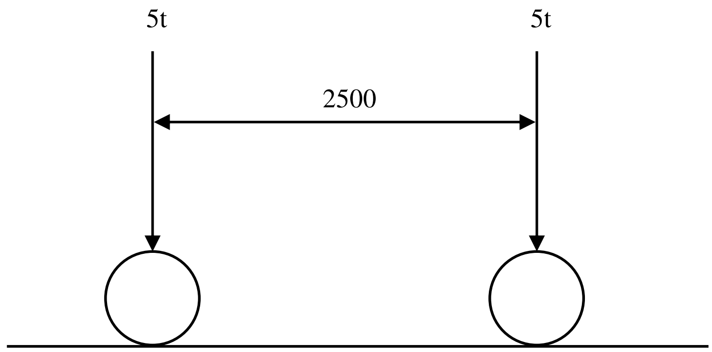
BROAD GAUGE – 1676 mm

DERAILMENT LOADS FOR BALLASTED DECK BRIDGES

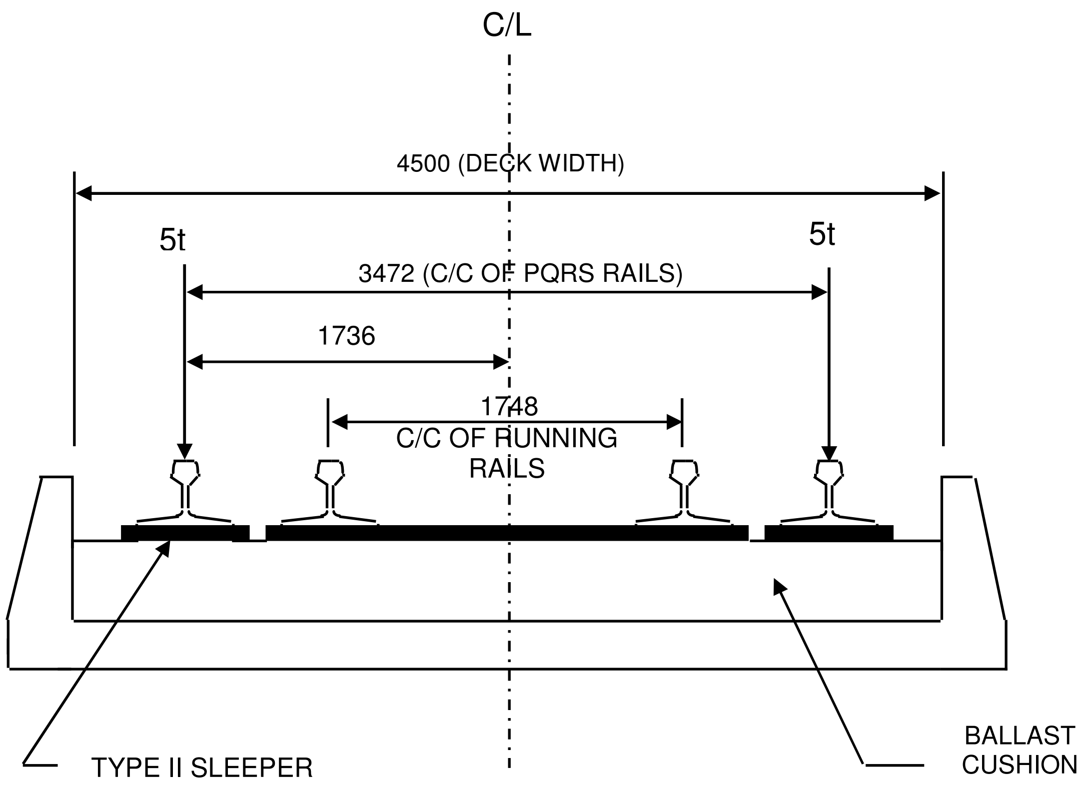
Sl. No.	Condition and approach	Bridges with guard rails	Bridges without guard rails
1.	**Serviceability -** There should be no permanent damage i.e. the stresses shall be within the working permissible stress.	a) Two vertical line loads of 15 kN/m (1.5 t/m) each 1.6m apart parallel to the track in most unfavourable position inside an area of 1.3m on either side of track centre line. b) A single load of 100 kN (10t) acting in an area of 1.3m on either side of the track centre line in the most unfavourable position.	a) Two vertical line loads of 15 kN/m(1.5 t/m) each 1.6m apart parallel to the track in most unfavourable position inside an area of 2.25m on either side of track centre line. b) A single load of 100 kN (10t) acting in an area of 2.25m on either side of the track centre line in the most unfavourable position.
2.	**Ultimate –** The load at which a derailed vehicle shall not cause collapse of any major element.	a) Two vertical line loads of 50 kN/m (5t/m) each 1.6m apart parallel to the track in the most unfavourable position inside an area of 1.3m on either side of track centre line. b) A single load of 200 kN (20t) acting on an area of 1.3m on either side of track centre line in the most unfavourable position.	a) Two vertical line loads of 50 kN/m (5 t/m) each 1.6m apart parallel to the track in the most unfavourable position inside an area of 2.25m on either side of track centre line. b) A single load of 200 kN (20t) acting on an area of 2.25m on either side of track centre line in the most unfavourable position.
3.	**Stability –** The structure shall not overturn.	A vertical line load of 80 kN/m (8t/m) with a total length of 20m acting on the edge of the structure under consideration.	A vertical line load of 80 kN/m (8t/m) with a total length of 20m acting on the edge of the structure under consideration.

APPENDIX X

BROAD GAUGE LIVE LOAD DUE TO WORKING OF PLASSER'S QUICK RELAY SYSTEM (PQRS)



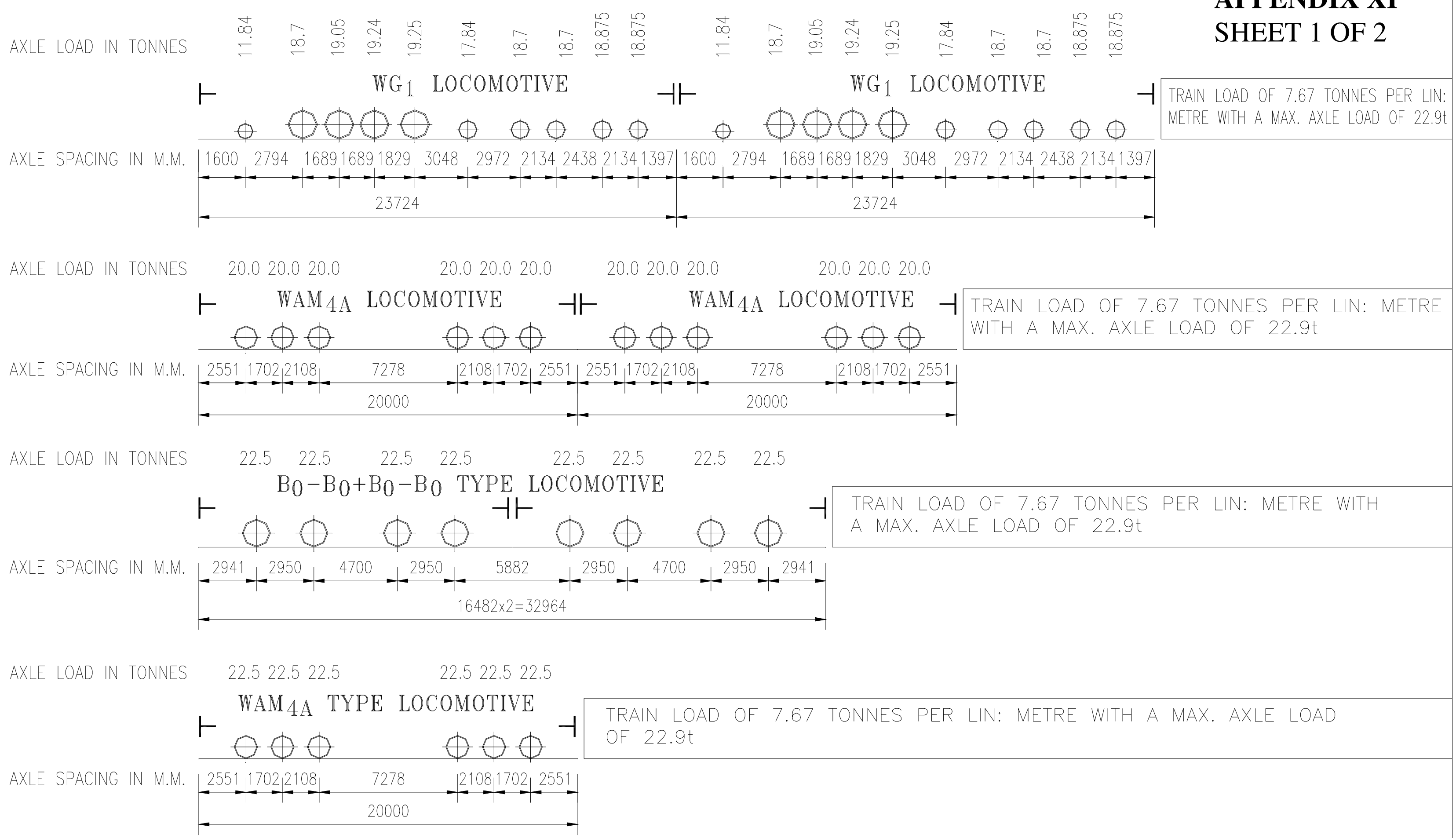
WHEEL LOAD DUE TO 9t PQRS PORTAL



CROSS SECTION OF PQRS LOADING IN DECK

(All dimensions are in millimeters)

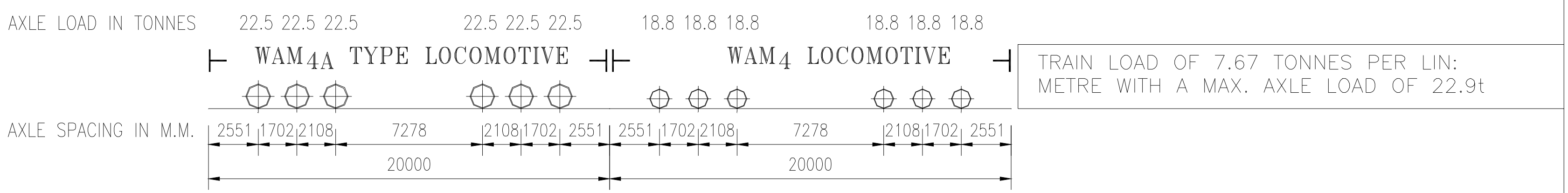
APPENDIX XI
SHEET 1 OF 2

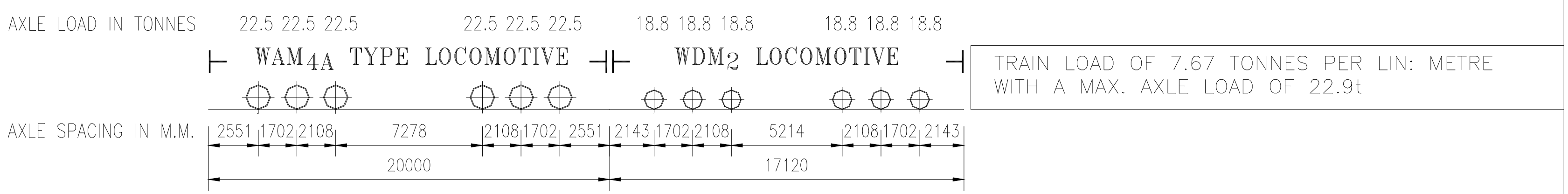


PREPARED BY MOHD. AZHAR/JE-I
CHECKED BY S.K.SINGH/ADE/B&S/SB-II

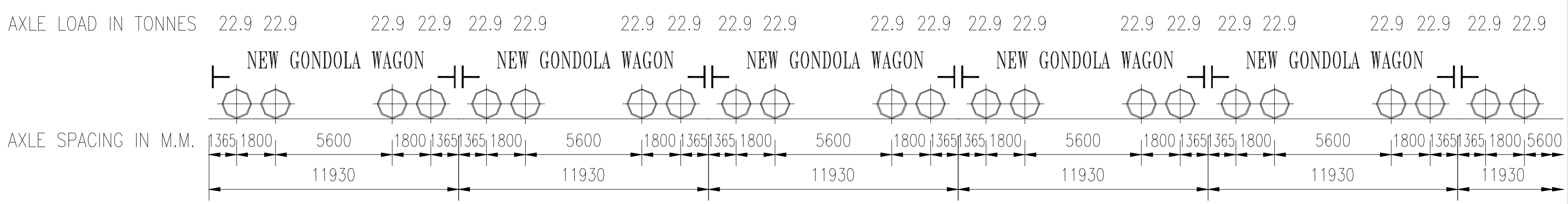
REVISED B.G. LOADING OF 1975

APPENDIX XI
SHEET 1 OF 2





NOTE:- THE FOLLOWING SERIES OF GONDOLA WAGONS OF 22.9t AXLE LOAD BEHIND THE LOCOMOTIVES ALSO FORMS AN ALTERNATIVE TO THE TRAIN LOAD OF 7.67 TONNES PER LINEAR METRE IN ALL THE ABOVE CASES.



PREPARED BY MOHD. AZHAR/JE-I
CHECKED BY S.K.SINGH/ADE/B&S/SB-II

REVISED B.G. LOADING OF 1975

APPENDIX-XII

BROAD GAUGE-1676 mm (5' 6")

Equivalent Uniformly Distributed Loads (EUDL) in tonnes on each track, and Impact Factors for BG Bridges for Revised Broad Gauge Standard Loading (RBG) –1975.

For Bending Moment, L is equal to the effective span in metres. For Shear Force, L is the loaded length in metres to give the maximum Shear in the member under consideration.

NOTE: *(1) Cross girders – The live load on a cross girder will be equal to half the total load for bending in a length L, equal to twice the distance over centres of cross girders, increased by the impact factor for the length L, as defined above.*

(2) When loaded length lies between the values given in the table, the EUDL for bending moment and shear force can be interpolated.

L (m)	Total load (tonnes) for Bending Moment	Total load (tonnes) for Shear	Impact Factor CDA= 20/(14+L)
1	**2**	**3**	**4**
1.0	45.8	45.8	1.000
1.5	45.8	45.8	1.000
2.0	45.8	51.7	1.000
2.5	45.8	59.4	1.000
3.0	46.2	64.5	1.000
3.5	51.6	68.1	1.000
4.0	55.8	73.0	1.000
4.5	59.2	79.9	1.000
5.0	66.5	85.4	1.000
5.5	72.7	89.9	1.000
6.0	77.9	93.7	1.000
6.5	82.3	96.8	0.976
7.0	86.1	100.4	0.952
7.5	89.3	105.9	0.931

1	2	3	4
8.0	92.2	110.7	0.909
8.5	94.7	115.0	0.889
9.0	96.9	118.8	0.870
9.5	99.6	122.2	0.851
10.0	103.6	125.2	0.833
11.0	119.9	130.6	0.800
12.0	125.2	138.6	0.769
13.0	129.7	145.3	0.741
14.0	136.0	151.1	0.714
15.0	142.1	157.8	0.691
16.0	147.4	165.1	0.667
17.0	154.1	173.0	0.645
18.0	162.3	181.2	0.625
19.0	169.6	190.3	0.606
20.0	177.1	199.1	0.588
21.0	184.8	207.1	0.571
22.0	192.9	214.3	0.556
23.0	200.5	221.0	0.541
24.0	207.4	227.5	0.526
25.0	213.7	235.6	0.513
26.0	221.8	243.1	0.500
27.0	229.6	250.1	0.488
28.0	237.6	257.5	0.476
29.0	245.0	265.4	0.465
30.0	252.0	273.3	0.455
32.0	265.0	290.3	0.435
34.0	279.4	305.6	0.417
36.0	293.8	319.4	0.400
38.0	308.8	334.6	0.385
40.0	325.2	349.8	0.370
42.0	340.1	365.5	0.357

APPENDIX-XII (Contd…)

1	2	3	4
44.0	353.6	382.1	0.345
46.0	368.1	397.3	0.333
48.0	382.8	411.6	0.323
50.0	397.2	426.7	0.313
55.0	434.3	465.9	0.290
60.0	470.9	503.7	0.270
65.0	508.3	542.0	0.253
70.0	546.9	581.2	0.238
75.0	584.0	618.8	0.225
80.0	621.8	657.9	0.213

1	2	3	4
85.0	660.5	695.5	0.202
90.0	698.0	734.1	0.192
95.0	736.1	772.6	0.183
100.0	775.1	810.6	0.175
105.0	812.9	849.8	0.168
110.0	851.1	887.5	0.161
115.0	888.7	926.4	0.155
120.0	926.7	964.4	0.149
125.0	965.1	1002.7	0.144
130.0	1002.8	1041.5	0.139

APPENDIX-XIII

BROAD GAUGE - 1676 mm (5'-6")

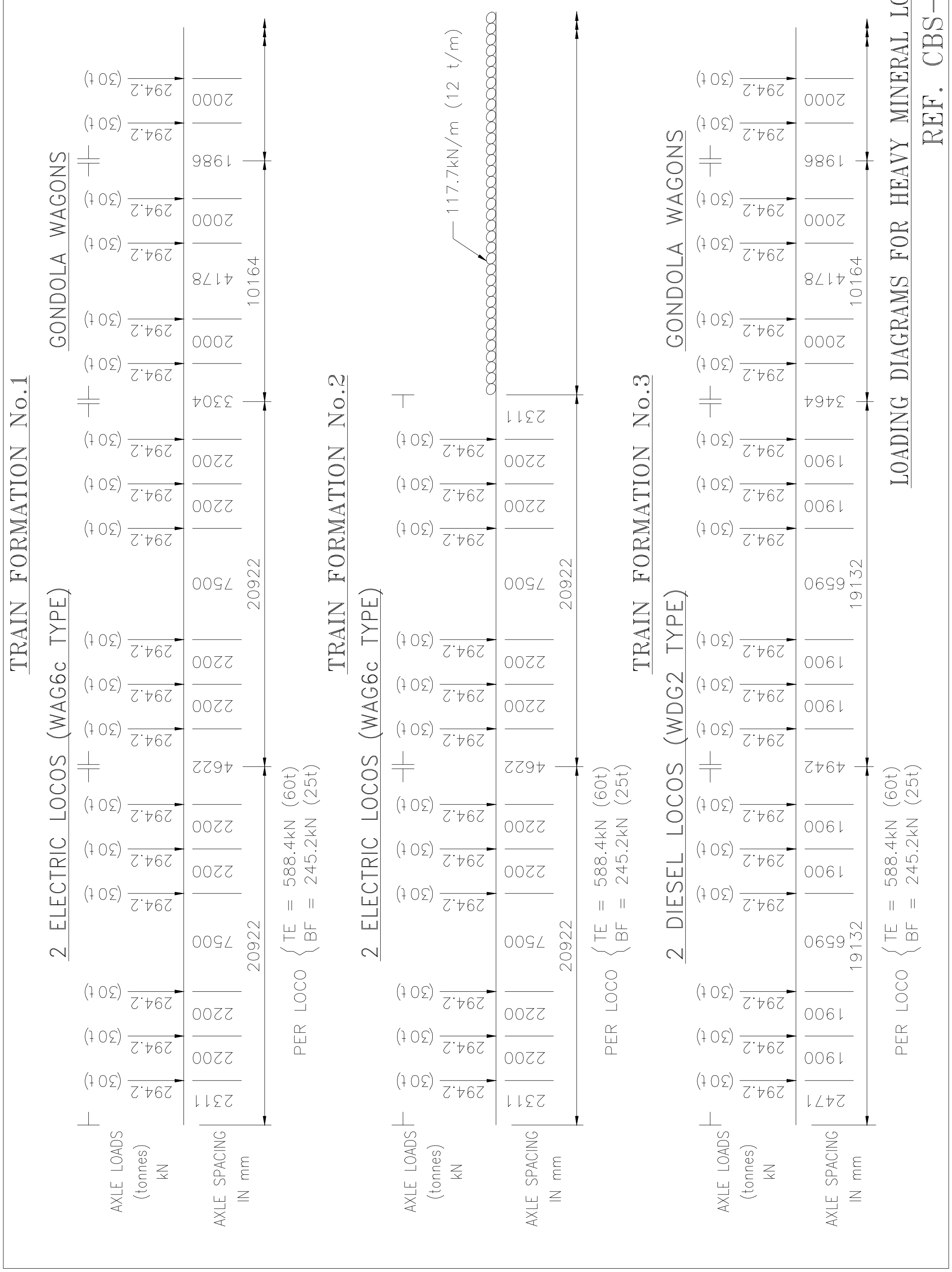
Longitudinal loads (without deduction for dispersion) for Revised Broad Gauge Standard Loading (RBG – 1975)

NOTE: *Where loaded length lies between the values given in the table, the tractive effort or braking force can, with safety, be assumed as that for the longer loaded length.*

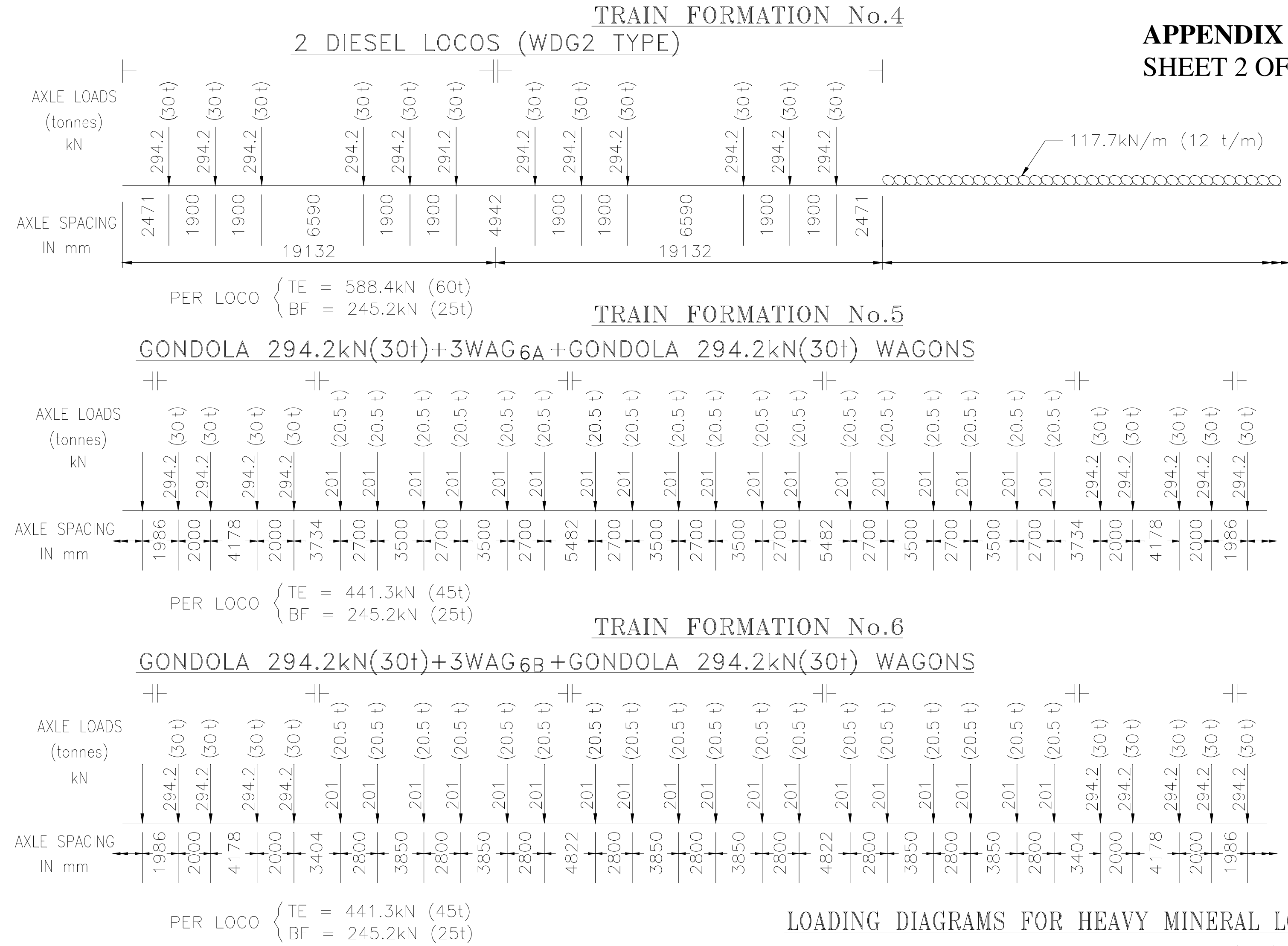
L (m)	Tractive Effort (tonnes)	Braking Force (tonnes)
1	**2**	**3**
1.0	7.5	4.6
1.5	7.5	4.6
2.0	15.0	9.2
2.5	15.0	9.2
3.0	15.0	9.2
3.5	15.0	11.4
4.0	22.5	13.5
4.5	22.5	13.5
5.0	22.5	13.7
5.5	22.5	15.2
6.0	22.5	15.2
6.5	22.5	18.3
7.0	22.5	18.3
7.5	22.5	18.3
8.0	22.5	18.3
8.5	25.0	18.3
9.0	27.5	18.3
9.5	27.5	20.4
10.0	27.5	22.7
11.0	32.5	22.7
12.0	32.5	22.9
13.0	37.5	24.8
14.0	37.5	27.5
15.0	45.0	27.5
16.0	45.0	28.3
17.0	45.0	32.1
18.0	45.0	32.1
19.0	45.0	36.6
20.0	50.0	36.6
21.0	50.0	36.6

1	2	3
22.0	55.0	41.0
23.0	55.0	41.0
24.0	60.0	41.2
25.0	60.0	42.1
26.0	60.0	45.8
27.0	60.0	45.8
28.0	60.0	46.7
29.0	65.0	50.4
30.0	65.0	50.4
32.0	70.0	55.0
34.0	75.0	59.3
36.0	75.0	59.5
38.0	75.0	64.1
40.0	75.0	65.1
42.0	75.0	68.7
44.0	75.0	73.3
46.0	75.0	77.6
48.0	75.0	77.9
50.0	75.0	82.4
55.0	75.0	91.6
60.0	75.0	96.2
65.0	75.0	105.3
70.0	75.0	114.3
75.0	75.0	119.1
80.0	75.0	128.2
85.0	75.0	134.1
90.0	75.0	146.6
95.0	75.0	150.9
100.0	75.0	160.3
105.0	75.0	169.2
110.0	75.0	174.0
115.0	75.0	183.2
120.0	75.0	187.8
125.0	75.0	196.9
130.0	75.0	205.9

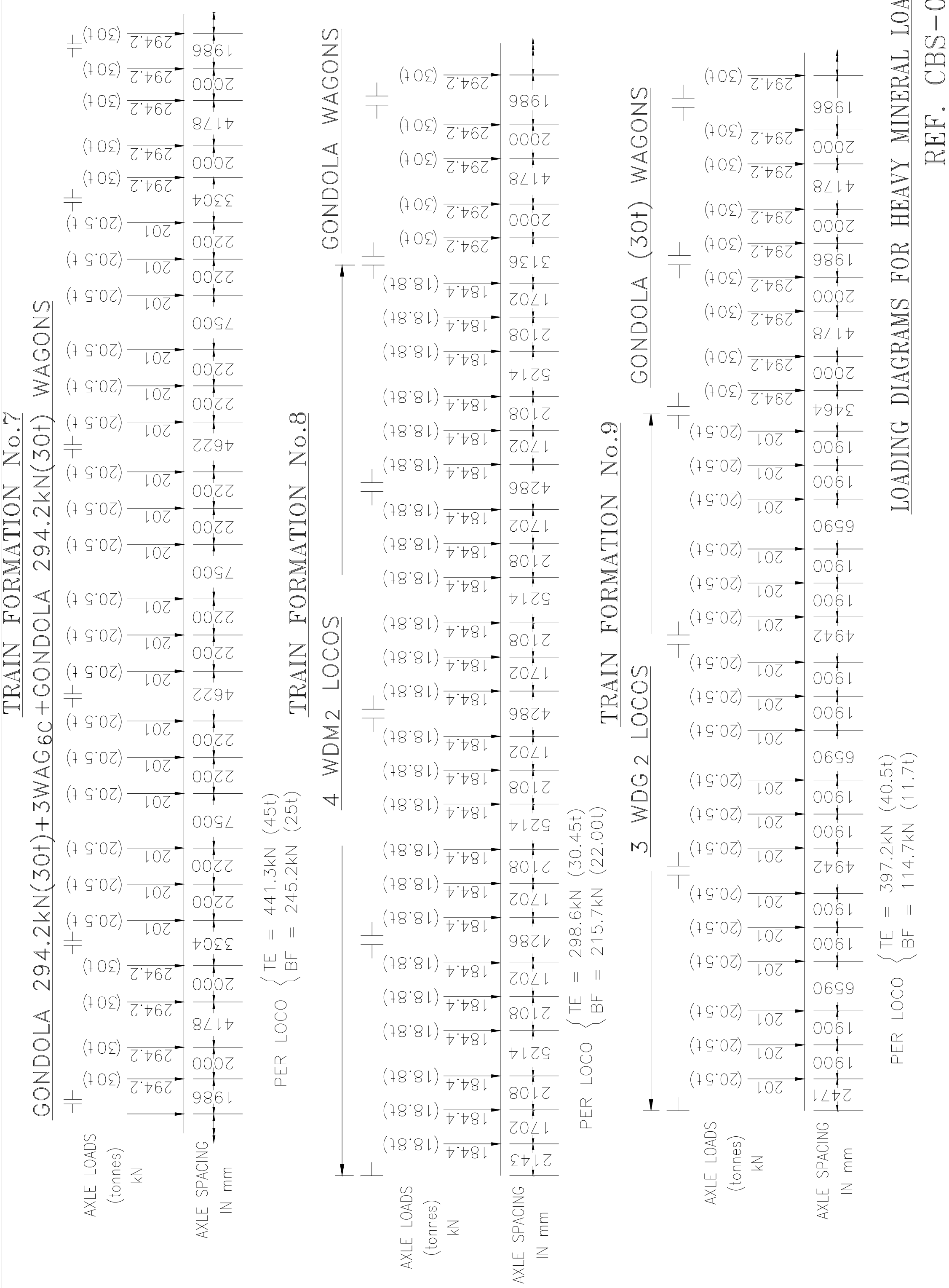
APPENDIX XIV
SHEET 1 OF 7



APPENDIX XIV
SHEET 2 OF 7



LOADING DIAGRAMS FOR HEAVY MINERAL LOADING
REF. CBS-0005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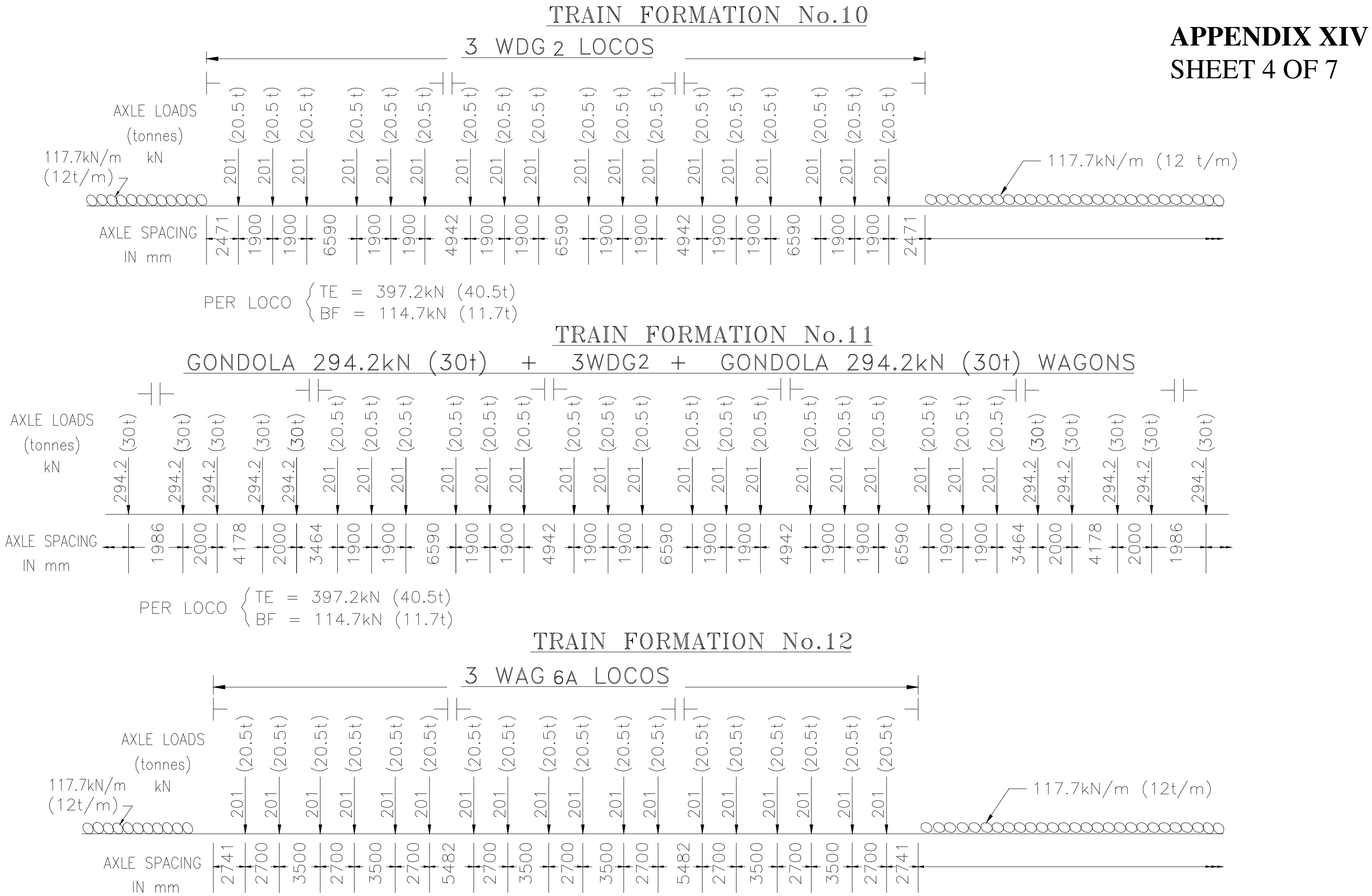
GONDOLA 294.2kN(30t)+3WAG6C+GONDOLA 294.2kN(30t) WAGONS
AXLE LOADS (tonnes) kN
AXLE SPACING IN mm
1986 2000 4178 2000 3304 2200 2200 7500 2200 2200 4622 2200 2200 7500 2200 2200 4622 2200 2200 7500 2200 2200 3304 2000 4178 2000 1986
PER LOCO TE = 441.3kN (45t) BF = 245.2kN (25t)
TRAIN FORMATION No.8
4 WDM2 LOCOS
GONDOLA WAGONS
2143 1702 2108 5214 2108 1702 4286 1702 2108 5214 2108 1702 4286 1702 2108 5214 2108 1702 4286 1702 2108 5214 2108 1702 3136 2000 4178 2000 1986
PER LOCO TE = 298.6kN (30.45t) BF = 215.7kN (22.00t)
TRAIN FORMATION No.9
3 WDG 2 LOCOS
GONDOLA (30t) WAGONS
2471 1900 1900 6590 1900 1900 4942 1900 1900 6590 1900 1900 4942 1900 1900 6590 1900 1900 3464 2000 4178 2000 1986 2000 4178 2000 1986
PER LOCO TE = 397.2kN (40.5t) BF = 114.7kN (11.7t)
LOADING DIAGRAMS FOR HEAVY MINERAL LOADING
REF. CBS-0005

APPENDIX XIV
SHEET 4 OF 7

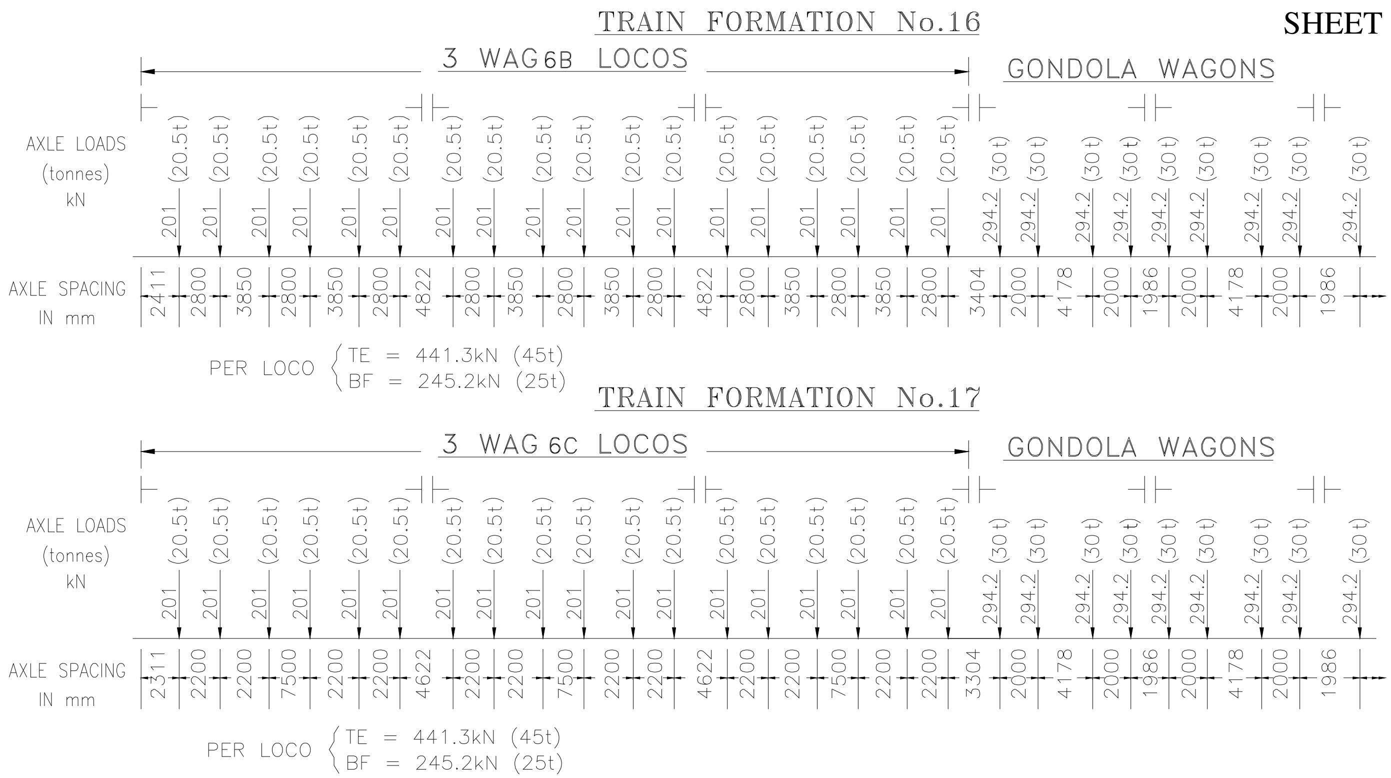


LOADING DIAGRAMS FOR HEAVY MINERAL LOADING
REF. CBS-0005

APPENDIX XIV
SHEET 5 OF 7

LOADING DIAGRAMS FOR HEAVY MINERAL LOADING
REF. CBS-0005

APPENDIX XIV
SHEET 6 OF 7

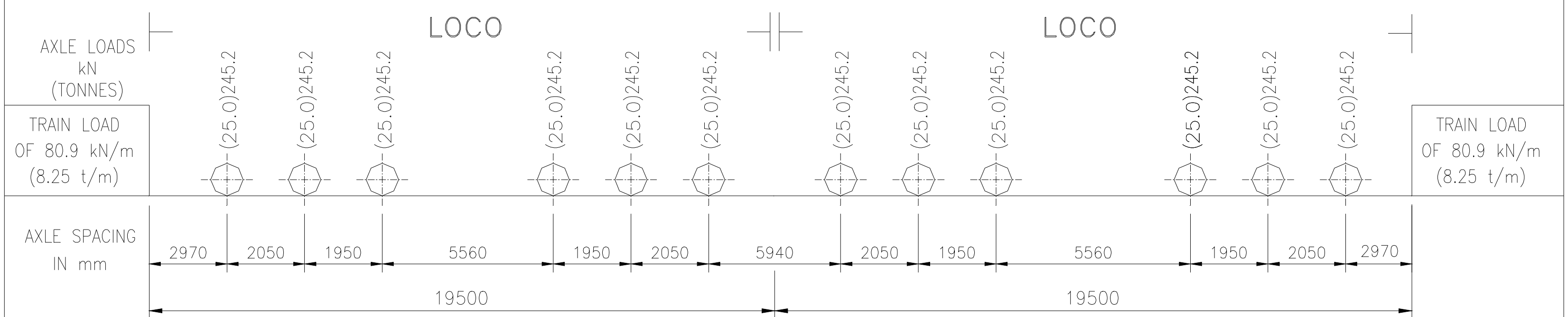


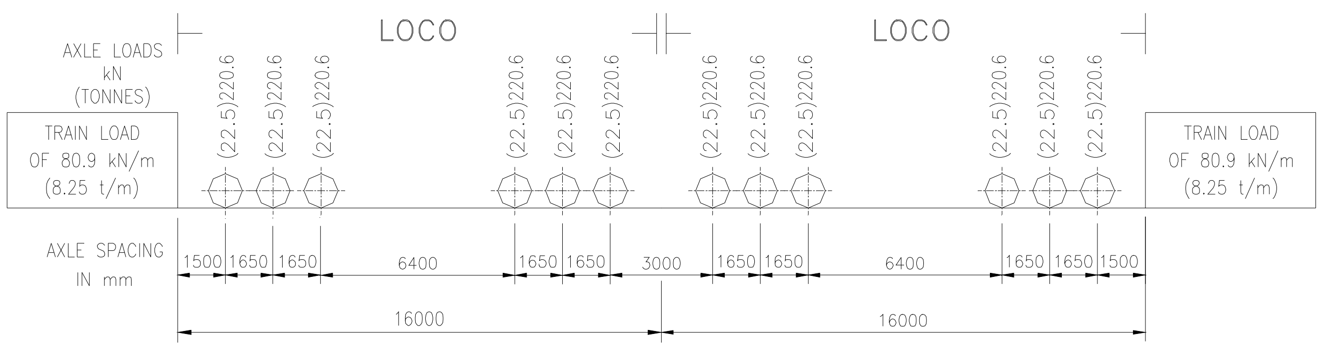
LOADING DIAGRAMS FOR HEAVY MINERAL LOADING

REF. CBS-0005

TRAIN FORMATIONS FOR MBG LOADING

APPENDIX I





LONGITUDINAL FORCES

TRACTIVE EFFORT PER LOCO....................490.3 kN (50.0 TONNES)
BRAKING FORCE PER LOCO AXLE............25% OF AXLE LOAD
BRAKING FORCE OF TRAIN LOAD...........13.4% OF TRAIN LOAD

MODIFIED B.G. LOADING-1987

CBS - 2347

TRACTIVE EFFORT FOR H.M. LOADING ....1323.9 kN (135.0 TONNES)
BRAKING FORCE OF TRAIN LOAD FOR ....13.4% OF TRAIN LOAD
H.M. LOADING

REF. CBS - 0005

APPENDIX XV

HEAVY MINERAL LOADING
BROAD GAUGE - 1676mm

Equivalent Uniformly Distributed Loads (EUDLS) in kilo - Newtons (tonnes) on each track and Coefficient of Dynamic Augment (CDA)

For Bending Moment, L is equal to the effective span in metres. For shear, L is the loaded length in metres to give the maximum shear in the member under consideration.

The Equivalent Uniformly Distributed Load (EUDL) for Bending Moment (BM), for spans upto 10m, is that uniformly distributed load which produces the BM at the centre of the span equal to the absolute maximum BM developed under the standard loads. For spans above 10m, the EUDL for BM, is that uniformly distributed load which produces the BM at one-sixth of the span equal to the BM developed at that section under the standard loads.

EUDL for Shear Force (SF) is that uniformly distributed load which produces SF at the end of the span equal to the maximum SF developed under the standard loads at that section.

Note:

(1) *Cross girders - The live load on a cross girder will be equal to half the total load for bending in a length L, equal to twice the distance over centres of cross girders.*

(2) *L for Coefficient of Dynamic Augment (CDA) shall be as laid down in Clause 2.4.1.*

(3) *When loaded length lies between the values given in the table, the EUDL for bending moment and shear can be interpolated.*

L (m)	Total Load for Bending moment		Total Load for Shear Force		Impact Factor CDA= 0.15+8/(6+L)
	KN	t	KN	t	
1	2	3	4	5	6
1.0	588	60.0	588	60.0	1.000
1.5	588	60.0	588	60.0	1.000
2.0	588	60.0	618	63.0	1.000
2.5	588	60.0	730	74.4	1.000
3.0	588	60.0	804	82.0	1.000
3.5	625	63.7	857	87.4	0.992
4.0	684	69.8	927	94.5	0.950
4.5	772	78.7	1020	104.0	0.912
5.0	871	88.8	1094	111.6	0.877
5.5	952	97.1	1155	117.8	0.846
6.0	1020	104.0	1206	123.0	0.817
6.5	1078	109.9	1270	129.5	0.790
7.0	1127	114.9	1347	137.4	0.765
7.5	1169	119.2	1414	144.2	0.743
8.0	1217	124.1	1473	150.2	0.721
8.5	1282	130.7	1525	155.5	0.702
9.0	1340	136.6	1571	160.2	0.683

L (m)	Total Load for Bending moment		Total Load for Shear Force		Impact Factor CDA= 0.15+8/(6+L)
	KN	t	KN	t	
9.5	1392	141.9	1612	164.4	0.666
10.0	1439	146.7	1649	168.2	0.650
11.0	1585	161.6	1768	180.3	0.621
12.0	1649	168.2	1856	189.3	0.594
13.0	1740	177.4	1978	201.7	0.571
14.0	1826	186.2	2089	213.0	0.550
15.0	1932	197.0	2218	226.2	0.531
16.0	2069	211.0	2337	238.3	0.514
17.0	2190	223.3	2471	252.0	0.498
18.0	2330	237.6	2596	264.7	0.483
19.0	2456	250.4	2707	276.0	0.470
20.0	2567	261.8	2807	286.2	0.458
21.0	2669	272.2	2916	297.4	0.446
22.0	2763	281.7	3024	308.4	0.436
23.0	2872	292.9	3140	320.2	0.426
24.0	2973	303.2	3255	331.9	0.417
25.0	3080	314.1	3375	344.2	0.408
26.0	3189	325.2	3495	356.4	0.400
27.0	3293	335.8	3621	369.2	0.392
28.0	3407	347.4	3743	381.7	0.385
29.0	3513	358.2	3857	393.3	0.379
30.0	3627	369.9	3964	404.2	0.372
32.0	3845	392.1	4185	426.8	0.361
34.0	4069	414.9	4415	450.2	0.350
36.0	4297	438.2	4652	474.4	0.340
38.0	4527	461.6	4895	499.2	0.332
40.0	4756	485.0	5122	522.3	0.324
42.0	4978	507.6	5345	545.0	0.317
44.0	5180	528.2	5575	568.5	0.310
46.0	5413	552.0	5810	592.5	0.304
48.0	5649	576.0	6051	617.0	0.298
50.0	5884	600.0	6279	640.3	0.293
55.0	6472	660.0	6848	698.3	0.281
60.0	7061	720.0	7436	758.3	0.271
65.0	7649	780.0	8006	816.4	0.263
70.0	8238	840.0	8595	876.4	0.255
75.0	8826	900.0	9164	934.5	0.249
80.0	9414	960.0	9752	994.4	0.243
85.0	10003	1020.0	10322	1052.6	0.238

L (m)	Total Load for Bending moment		Total Load for Shear Force		Impact Factor CDA= 0.15+8/(6+L)
	KN	t	KN	t	
90.0	10591	1080.0	10909	1112.4	0.233
95.0	11180	1140.0	11483	1170.9	0.229
100.0	11768	1200.0	12129	1236.8	0.225
105.0	12356	1260.0	12657	1290.7	0.222
110.0	12945	1320.0	13246	1350.7	0.219
115.0	13533	1380.0	13833	1410.6	0.216
120.0	14122	1440.0	14422	1470.6	0.213
125.0	14710	1500.0	15009	1530.5	0.211
130.0	15298	1560.0	15597	1590.5	0.209

EUDL for BM and Shear given in this Appendix are not applicable for ballasted deck for spans upto and including 8.0m for which Appendix XV (a) is to be referred.

APPENDIX XV (a)

HEAVY MINERAL LOADING
BROAD GAUGE-1676mm

1. Equivalent Uniformly Distributed Load (EUDL) for Bending Moment in kilo-Newton/(tonnes) for cushions of various depths and spans upto and including 8m.

For bending moment L is equal to the effective span in metres.

Note:

(1) *For intermediate values of L and cushions, the EUDL shall be arrived at by linear interpolation.*

(2) *The figures given below do not include dynamic effect.*

L (m)	EUDL for bending moment							
	Cushion (mm)							
	200		300		400		600	
	kN	t	kN	t	kN	t	kN	t
0.5	322	32.8	266	27.1	225	22.9	173	17.6
1.0	455	46.4	426	43.4	396	40.4	337	34.4
1.5	499	50.9	480	48.9	460	46.9	421	42.9
2.0	522	53.2	507	51.7	492	50.2	463	47.2
2.5	535	54.6	523	53.4	512	52.2	488	49.8
3.0	544	55.5	534	54.5	525	53.5	511	52.1
3.5	586	59.8	579	59.0	570	58.1	563	56.4
4.0	651	66.4	643	65.6	636	64.9	622	63.4
4.5	741	75.6	735	75.0	729	74.3	716	73.0
5.0	844	86.1	838	85.5	833	84.9	821	83.7
5.5	928	94.6	923	94.1	917	93.5	906	92.4
6.0	997	101.7	992	101.2	988	100.7	978	99.7
7.0	1107	112.9	1103	112.5	1099	112.1	1090	111.2
8.0	1200	122.4	1196	122.0	1193	121.7	1186	120.9

2. Equivalent Uniformly Distributed Load (EUDL) for Shear in kilo-Newton/(tonnes) for cushions of various depths and spans upto and including 8m.

For shear L is the loaded length in metres to give the maximum shear in the member.

Note:

(1) *For intermediate values of L and cushions, the EUDL shall be arrived at by linear interpolation.*

(2) *The figures given below do not include dynamic effect.*

L (m)	EUDL for Shear Force							
	Cushion (mm)							
	200		300		400		600	
	kN	t	kN	t	kN	t	kN	t
0.5	322	32.8	266	27.1	225	22.9	173	17.6
1.0	455	46.4	426	43.4	396	40.4	337	34.4
1.5	499	50.9	480	48.9	460	46.9	421	42.9
2.0	532	54.3	516	52.6	500	51.0	469	47.8
2.5	629	64.1	606	61.8	585	59.6	541	55.2
3.0	715	72.9	695	70.9	676	68.9	637	65.0
3.5	781	79.6	764	77.9	747	76.2	714	72.8
4.0	848	86.5	830	84.6	813	82.9	781	79.6
4.5	931	94.9	911	92.9	891	90.9	852	86.9
5.0	1014	103.4	996	101.6	978	99.8	943	96.2
5.5	1083	110.4	1067	108.8	1050	107.1	1018	103.8
6.0	1140	116.2	1125	114.7	1110	113.2	1081	110.2
7.0	1271	129.6	1254	127.9	1238	126.2	1203	122.7
8.0	1406	143.4	1392	141.9	1377	140.4	1347	137.4

HEAVY MINERAL LOADING
BROAD GAUGE - 1676 mm

Longitudinal loads in kN (tonnes) without deduction for dispersion

Note: *Where loaded length lies between the values given in the table, the tractive effort or braking force can, with safety, be assumed as that for the longer loaded length.*

L (Loaded Length in Metres)	Tractive Effort		Braking Force	
	KN	t	KN	t
1	2	3	4	5
1.0	98	10.0	62	6.3
1.5	98	10.0	62	6.3
2.0	196	20.0	123	12.5
2.5	196	20.0	123	12.5
3.0	196	20.0	123	12.5
3.5	245	25.0	166	16.9
4.0	294	30.0	184	18.8
4.5	294	30.0	184	18.8
5.0	294	30.0	184	18.8
5.5	294	30.0	184	18.8
6.0	294	30.0	184	18.8
6.5	327	33.3	221	22.5
7.0	327	33.3	221	22.5
7.5	327	33.3	221	22.5
8.0	409	41.7	276	28.1
8.5	409	41.7	276	28.1
9.0	409	41.7	276	28.1
9.5	409	41.7	276	28.1
10.0	490	50.0	331	33.8
11.0	490	50.0	331	33.8
12.0	490	50.0	331	33.8
13.0	588	60.0	331	33.8
14.0	588	60.0	368	37.5
15.0	588	60.0	368	37.5
16.0	588	60.0	386	39.4
17.0	588	60.0	386	39.4
18.0	654	66.7	441	45.0
19.0	654	66.7	441	45.0
20.0	735	75.0	496	50.6
21.0	735	75.0	498	50.8
22.0	785	80.0	510	52.0
23.0	882	90.0	521	53.1
24.0	882	90.0	552	56.3
25.0	882	90.0	552	56.3
26.0	882	90.0	553	56.4
27.0	882	90.0	564	57.5
28.0	899	91.7	607	61.9
29.0	981	100.0	662	67.5
30.0	981	100.0	662	67.5
32.0	1079	110.0	679	69.2
34.0	1177	120.0	735	75.0
36.0	1177	120.0	735	75.0
38.0	1177	120.0	757	77.2
40.0	1177	120.0	779	79.4
42.0	1177	120.0	800	81.6
44.0	1177	120.0	822	83.8
46.0	1177	120.0	843	86.0
48.0	1177	120.0	865	88.2
50.0	1177	120.0	887	90.4
55.0	1250	127.5	941	96.0
60.0	1324	135.0	995	101.5
65.0	1324	135.0	1064	108.5
70.0	1324	135.0	1133	115.5
75.0	1324	135.0	1206	123.0
80.0	1324	135.0	1286	131.1
85.0	1324	135.0	1364	139.1
90.0	1324	135.0	1443	147.1
95.0	1324	135.0	1522	155.2
100.0	1324	135.0	1600	163.2
105.0	1324	135.0	1680	171.3
110.0	1324	135.0	1758	179.3
115.0	1324	135.0	1837	187.3
120.0	1324	135.0	1916	195.4
125.0	1324	135.0	1995	203.4
130.0	1324	135.0	2074	211.5

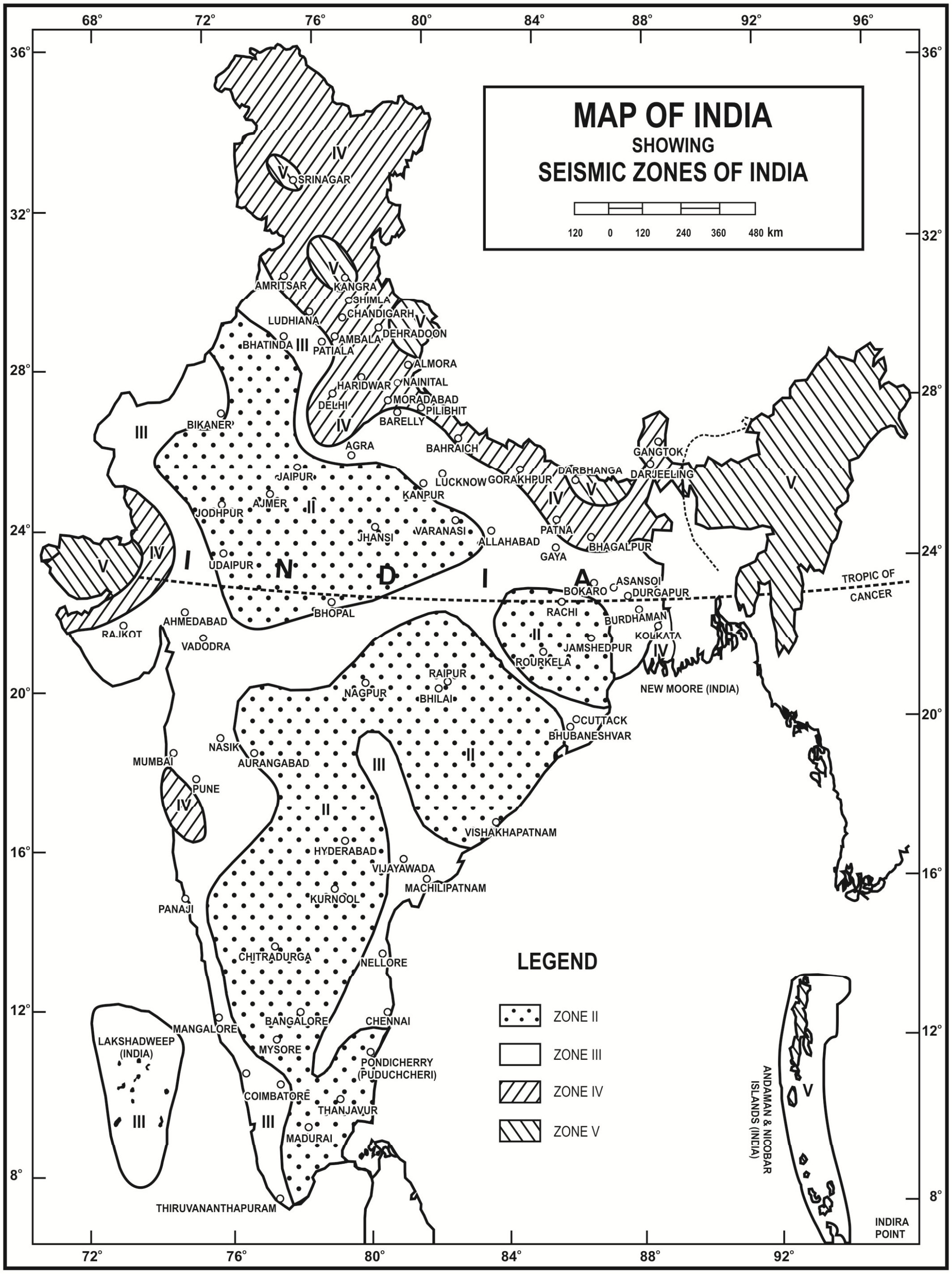
APPENDIX XVII

DERAILMENT LOADS FOR BALLASTED DECK BRIDGES (H.M. LOADING)

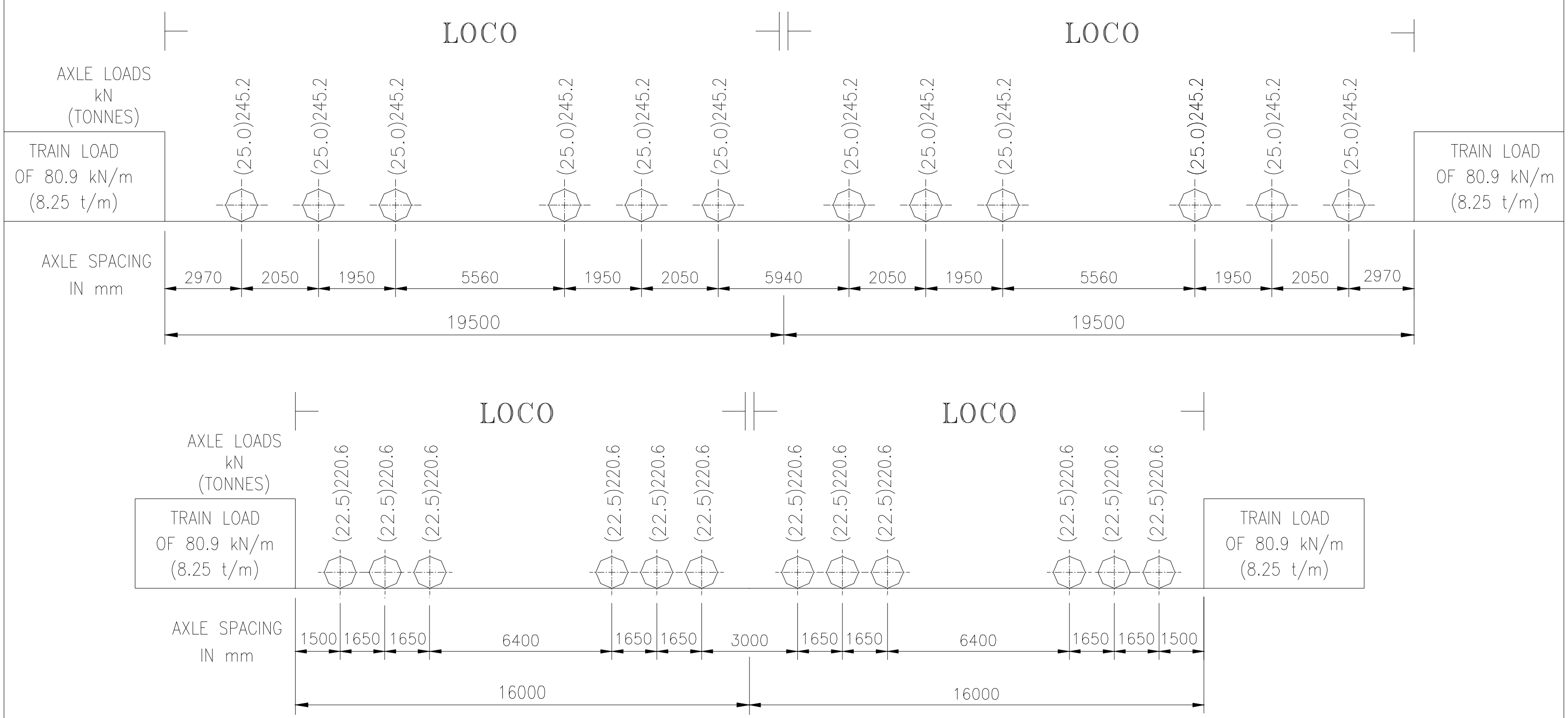
Sl. No.	Condition and approach	Bridges with guard rails	Bridges without guard rails
1.	**Serviceability -** There should be no permanent damage i.e. the stresses shall be within the working permissible stress.	a) Two vertical line loads of 15 kN/m (1.5 t/m) each 1.6m* apart parallel to the track in most unfavourable position inside an area of 1.3m on either side of track centre line. b) A single load of 100 kN (10t) acting in an area of 1.3m on either side of the track centre line in the most unfavourable position.	a) Two vertical line loads of 15 kN/m (1.5 t/m) each 1.6m* apart parallel to the track in most unfavourable position inside an area of 2.25m on either side of track centre line. b) A single load of 100 kN (10t) acting in an area of 2.25m on either side of the track centre line in the most unfavourable position.
2.	**Ultimate –** The load at which a derailed vehicle shall not cause collapse of any major element.	a) Two vertical line loads of 100 kN/m (10t/m) each 1.6m* apart parallel to the track in the most unfavourable position inside an area of 1.3m on either side of track centre line. b) A single load of 240 kN (24t) acting on an area of 1.3m on either side of track centre line in the most unfavourable position.	a) Two vertical line loads of 100 kN/m (10t/m) each 1.6m* apart parallel to the track in the most unfavourable position inside an area of 2.25m on either side of track centre line. b) A single line load of 240 kN (24t) acting on an area of 2.25m on either side of track centre line in the most unfavourable position.
3.	**Stability –** The structure shall not overturn.	A vertical line load of 120 kN/m (12t/m) with a total length of 20m acting on the edge of the structure under consideration.	A vertical line load of 120 kN/m (12t/m) with a total length of 20m acting on the edge of the structure under consideration

** The distance 1.6m is based on Broad Gauge distance 1.676m as adopted for derailment loads for MBG-1987 loading.*

APPENDIX XVIII



APPENDIX XIX



LONGITUDINAL FORCES

TRACTIVE EFFORT PER LOCO....................490.3 kN (50.0 TONNES)
BRAKING FORCE PER LOCO AXLE............25% OF AXLE LOAD
BRAKING FORCE OF TRAIN LOAD.............13.4% OF TRAIN LOAD

MODIFIED B.G. LOADING-1987

CBS - 2347

APPENDIX XX
MODIFIED BG LOADING-1987
BROAD GAUGE-1676 mm
Equivalent Uniformly Distributed Loads (EUDL) in kilo Newtons (tonnes) on each track, and Coefficient of Dynamic Augment (CDA).

For Bending Moment, L is equal to the effective span in metres. For Shear, L is the loaded length in metres to give the maximum Shear in the member under consideration.

The Equivalent Uniformly Distributed Load (EUDL) for Bending Moment (BM), for spans upto 10m, is that uniformly distributed load which produces the BM at the centre of the span equal to the absolute maximum BM developed under the standard loads. For spans above 10m, the EUDL for BM, is that uniformly distributed load which produces the BM at one-sixth of the span equal to the BM developed at that section under the standard loads.

EUDL for Shear Force (SF) is that uniformly distributed load which produces SF at the end of the span equal to the maximum SF developed under the standard loads at that section.

NOTE:

(1) *Cross girders – The live load on a cross girder will be equal to half the total load for bending in a length L, equal to twice the distance over centres of cross girders.*

(2) *L for Coefficient of Dynamic Augment (CDA) shall be as laid down in clause 2.4.1*

(3) *When loaded length lies between the values given in the table, the EUDL for Bending Moment and Shear can be interpolated.*

L (m)	Total load for Bending Moment		Total load for Shear Force		Impact Factor CDA= 0.15+8/(6+L)
	kN	t	kN	t	
1	2	3	4	5	6
1.0	490	50.0	490	50.0	1.000
1.5	490	50.0	490	50.0	1.000
2.0	490	50.0	519	52.9	1.000
2.5	490	50.0	598	61.0	1.000
3.0	490	50.0	662	67.5	1.000
3.5	516	52.6	707	72.1	.992
4.0	596	60.8	778	79.3	.950
4.5	677	69.0	838	85.5	.912
5.0	741	75.6	888	90.5	.877
5.5	794	81.0	941	95.9	.846
6.0	838	85.5	985	100.4	.817
6.5	876	89.3	1024	104.4	.790
7.0	911	92.9	1068	108.9	.765
7.5	948	96.7	1111	113.3	.743
8.0	981	100.0	1154	117.7	.721
8.5	1010	102.9	1210	123.4	.702
9.0	1040	106.1	1265	129.0	.683

APPENDIX XX (Contd…)

1	2	3	4	5	6
9.5	1070	109.1	1315	134.1	.666
10.0	1101	112.3	1377	140.4	.650
11.0	1282	130.7	1492	152.2	.621
12.0	1377	140.4	1589	162.0	.594
13.0	1475	150.4	1670	170.3	.571
14.0	1558	158.9	1740	177.4	.550
15.0	1631	166.3	1801	183.6	.531
16.0	1695	172.8	1853	189.0	.514
17.0	1751	178.5	1926	196.4	.498
18.0	1820	185.6	1999	203.9	.483
19.0	1886	192.4	2080	212.1	.470
20.0	1964	200.3	2168	221.1	.458
21.0	2039	207.9	2254	229.8	.446
22.0	2123	216.5	2337	238.3	.436
23.0	2203	224.7	2420	246.8	.426
24.0	2280	232.5	2503	255.2	.417
25.0	2356	240.2	2586	263.7	.408
26.0	2431	247.9	2668	272.1	.400
27.0	2506	255.5	2751	280.5	.392
28.0	2580	263.1	2833	288.9	.385
29.0	2654	270.6	2915	297.3	.379
30.0	2727	278.1	2997	305.7	.372
32.0	2874	293.0	3161	322.4	.361
34.0	3034	309.3	3325	339.1	.350
36.0	3191	325.3	3489	355.8	.340
38.0	3345	341.1	3652	372.4	.332
40.0	3498	356.7	3815	389.1	.324
42.0	3649	372.1	3978	405.7	.317
44.0	3798	387.3	4141	422.3	.310
46.0	3947	402.4	4304	438.9	.304
48.0	4094	417.4	4467	455.5	.298
50.0	4253	433.7	4630	472.1	.293
55.0	4658	474.9	5036	513.6	.281
60.0	5051	515.1	5442	555.0	.271
65.0	5436	554.3	5848	596.4	.263
70.0	5831	594.6	6254	637.7	.255
75.0	6220	634.3	6660	679.1	.249
80.0	6603	673.3	7065	720.4	.243

APPENDIX XX (Contd…)

1	2	3	4	5	6
85.0	6986	712.4	7470	761.8	.238
90.0	7391	753.7	7876	803.1	.233
95.0	7796	795.0	8281	844.4	.229
100.0	8201	836.2	8686	885.7	.225
105.0	8606	877.7	9091	927.0	.222
110.0	9011	918.8	9496	968.3	.219
115.0	9415	960.1	9901	1009.6	.216
120.0	9820	1001.4	10306	1050.9	.213
125.0	10225	1042.7	10711	1092.2	.211
130.0	10630	1083.9	11115	1133.5	.209

EUDL for BM and Shear Force given in this Appendix are not applicable for ballasted deck for spans upto and including 8.0m for which Appendix XX(a) is to be referred.

APPENDIX XX (a)

MODIFIED BG LOADING-1987
BROAD GAUGE 1676mm

1. Equivalent Uniformly Distributed Load (EUDL) for Bending Moment in Kilo-Newton (tonnes) for cushions of various depths and spans upto and including 8m.

For Bending Moment, L is equal to the effective span in metres.

NOTE:

(1) *For intermediate values of L and cushions, the EUDL shall be arrived at by linear interpolation.*

(2) *The figures given below do not include dynamic effects.*

L	EUDL for Bending Moment							
	Cushion (mm)							
	200		300		400		600	
Metres	KN	t	kN	t	KN	t	KN	t
0.5	268	27.4	222	22.6	188	19.2	144	14.7
1.0	379	38.7	355	36.2	330	33.7	281	28.7
1.5	416	42.5	400	40.8	384	39.2	351	35.8
2.0	435	44.4	423	43.1	410	41.9	386	39.4
2.5	446	45.5	437	44.5	427	43.5	407	41.5
3.0	454	46.2	445	45.4	437	44.6	423	43.2
3.5	490	50.0	483	49.3	476	48.6	462	47.1
4.0	571	58.2	566	57.7	564	57.5	559	57.0
4.5	655	66.8	650	66.3	645	65.8	635	65.8
5.0	722	73.6	717	73.2	713	72.7	704	71.8
5.5	776	79.2	772	78.8	768	78.4	760	77.6
6.0	822	83.8	818	83.5	815	83.1	807	82.3
7.0	894	91.2	891	90.8	887	90.5	881	89.9
8.0	965	98.4	962	98.1	959	97.8	953	97.2

2. Equivalent Uniformly Distributed Load (EUDL) for Shear in Kilo-Newton/tonnes for cushions of various depths and spans upto and including 8m.

For Shear Force, **L** is the loaded length in metres to give the maximum Shear Force in the member.

NOTE:

(1) *For intermediate values of **L** and cushions, the EUDL shall be arrived at by linear interpolation.*

(2) *The figures given below do not include dynamic effects.*

L	EUDL for Shear							
	Cushion (mm)							
	200		300		400		600	
Metres	**KN**	**t**	**KN**	**t**	**KN**	**t**	**KN**	**t**
0.5	268	27.3	222	22.6	188	19.2	144	14.7
1.0	379	38.7	355	36.2	330	33.7	281	28.7
1.5	416	42.5	400	40.8	384	39.1	351	35.8
2.0	443	45.2	429	43.8	416	42.4	390	39.8
2.5	516	52.7	499	50.9	482	49.1	447	45.6
3.0	588	60.0	572	58.3	555	56.7	524	53.5
3.5	644	65.7	630	64.3	616	62.9	588	60.0
4.0	703	71.7	688	70.1	673	68.6	643	65.6
4.5	772	78.7	757	77.2	743	75.7	713	72.7
5.0	827	84.4	814	83.0	801	81.7	774	79.0
5.5	880	89.8	867	88.4	853	87.0	827	84.3
6.0	929	94.8	917	93.5	905	92.3	880	89.8
7.0	1007	102.7	996	101.6	986	101.0	965	98.4
8.0	1097	111.8	1086	110.8	1076	109.7	1055	107.6

APPENDIX XXI

MODIFIED BG LOADING-1987
BROAD GAUGE - 1676 mm

Longitudinal loads (without deduction for dispersion)

NOTE: *Where loaded length lies between the values given in the Table, the tractive effort or braking force can, with safety, be assumed as that for the longer loaded length.*

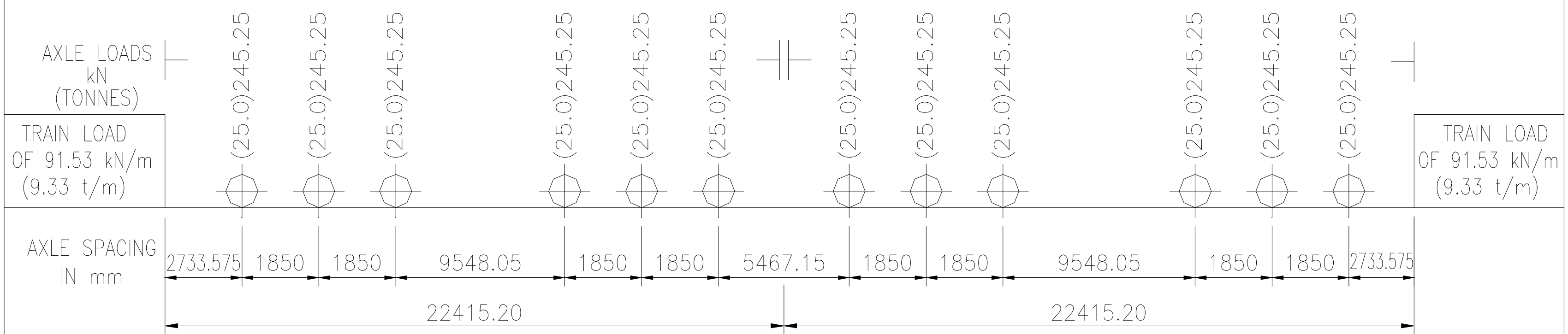
L (Loaded length in metres)	Tractive effort		Braking force	
	kN	t	kN	t
1	2	3	4	5
1.0	81	8.3	62	6.3
1.5	81	8.3	62	6.3
2.0	164	16.7	123	12.5
2.5	164	16.7	123	12.5
3.0	164	16.7	123	12.5
3.5	245	25.0	166	16.9
4.0	245	25.0	184	18.8
4.5	245	25.0	184	18.8
5.0	245	25.0	184	18.8
5.5	245	25.0	184	18.8
6.0	245	25.0	184	18.8
6.5	327	33.3	221	22.5
7.0	327	33.3	221	22.5
7.5	327	33.3	221	22.5
8.0	409	41.7	276	28.1
8.5	409	41.7	276	28.1
9.0	409	41.7	276	28.1
9.5	409	41.7	276	28.1
10.0	490	50.0	331	33.8
11.0	490	50.0	331	33.8
12.0	490	50.0	331	33.8
13.0	490	50.0	331	33.8
14.0	490	50.0	368	37.5
15.0	490	50.0	368	37.5
16.0	572	58.3	386	39.4
17.0	572	58.3	386	39.4
18.0	654	66.7	441	45.0
19.0	654	66.7	441	45.0
20.0	735	75.0	496	50.6
21.0	735	75.0	498	50.8

1	2	3	4	5
22.0	735	75.0	510	52.0
23.0	735	75.0	521	53.1
24.0	735	75.0	552	56.3
25.0	735	75.0	552	56.3
26.0	817	83.3	553	56.4
27.0	817	83.3	564	57.5
28.0	899	91.7	607	61.9
29.0	981	100.0	662	67.5
30.0	981	100.0	662	67.5
32.0	981	100.0	679	69.2
34.0	981	100.0	735	75.0
36.0	981	100.0	735	75.0
38.0	981	100.0	757	77.2
40.0	981	100.0	779	79.4
42.0	981	100.0	800	81.6
44.0	981	100.0	822	83.8
46.0	981	100.0	843	86.0
48.0	981	100.0	865	88.2
50.0	981	100.0	887	90.4
55.0	981	100.0	941	96.0
60.0	981	100.0	995	101.5
65.0	981	100.0	1049	107.0
70.0	981	100.0	1104	112.6
75.0	981	100.0	1158	118.1
80.0	981	100.0	1212	123.6
85.0	981	100.0	1266	129.1
90.0	981	100.0	1321	134.7
95.0	981	100.0	1375	140.2
100.0	981	100.0	1429	145.7
105.0	981	100.0	1483	151.2
110.0	981	100.0	1538	156.8
115.0	981	100.0	1592	162.3
120.0	981	100.0	1646	167.8
125.0	981	100.0	1700	173.4
130.0	981	100.0	1754	178.9

APPENDIX-XXII

SHEET 1 OF 4

COMBINATION-1: DOUBLE HEADED DIESEL LOCO

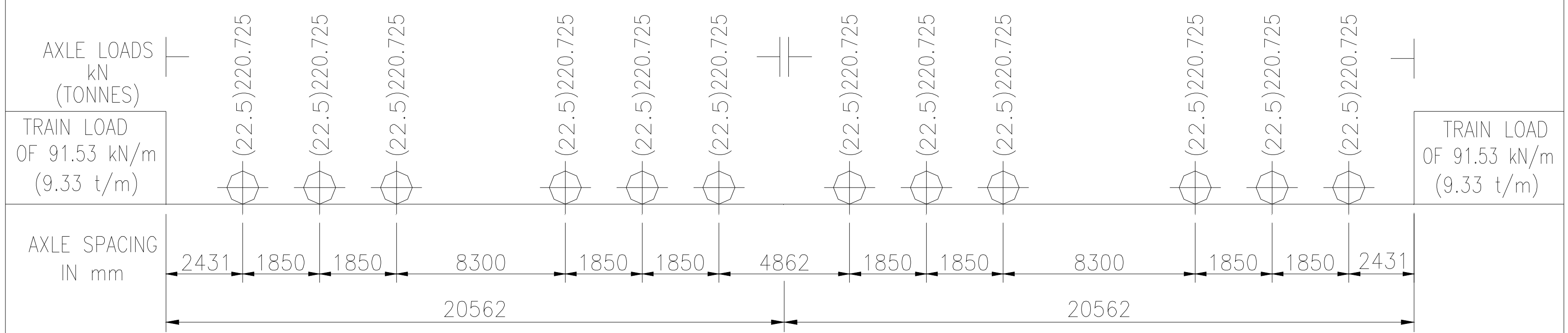


LONGITUDINAL FORCES

TRACTIVE EFFORT PER LOCO....................63.0 TONNES (618.03 kN)
BRAKING FORCE PER LOCO AXLE............25% OF AXLE LOAD
BRAKING FORCE OF TRAIN LOAD.............13.4% OF TRAIN LOAD

"25t LOADING-2008"

COMBINATION-2: DOUBLE HEADED ELECTRIC LOCO (2 WAG9H)

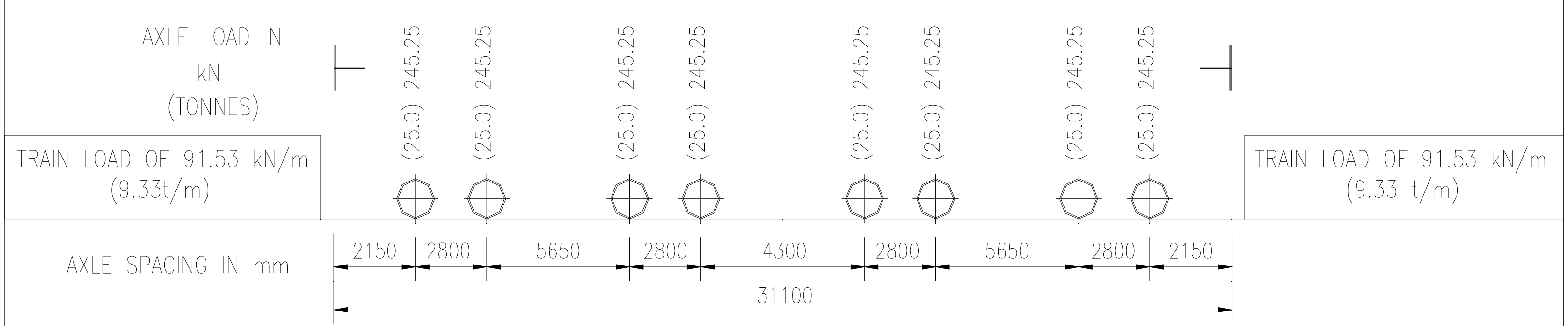


LONGITUDINAL FORCES

TRACTIVE EFFORT PER LOCO....................52.0 TONNES (510.12 kN)
BRAKING FORCE PER LOCO AXLE............25% OF AXLE LOAD
BRAKING FORCE OF TRAIN LOAD.............13.4% OF TRAIN LOAD

"25t LOADING-2008"

COMBINATION-3: ELECTRIC LOCO [(Bo-Bo)+(Bo-Bo)]



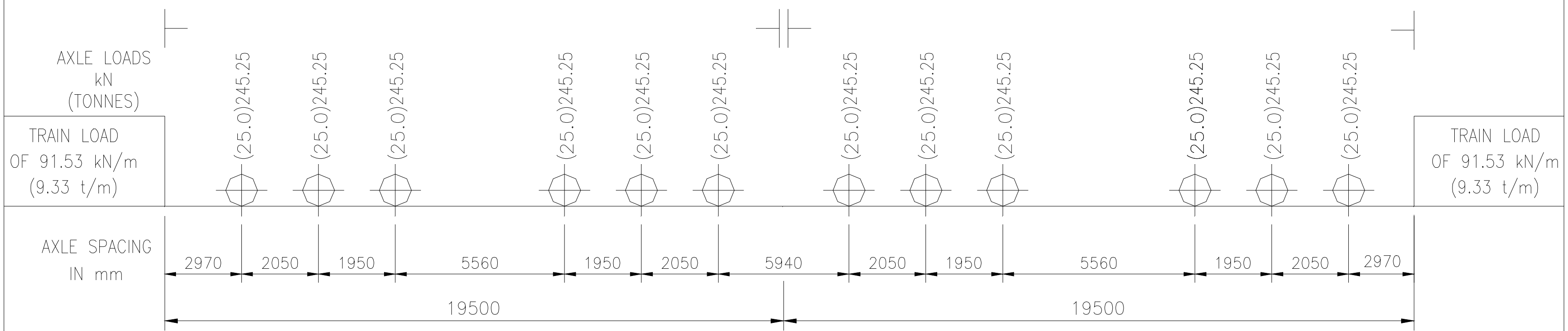
LONGITUDINAL FORCES

TRACTIVE EFFORT PER LOCO--------------- 84.0 TONNES (824.04 kN)
BRAKING FORCE PER LOCO AXLE ----------- 25% OF AXLE LOAD
BRAKING FORCE OF TRAIN LOAD ----------- 13.4% OF TRAIN LOAD

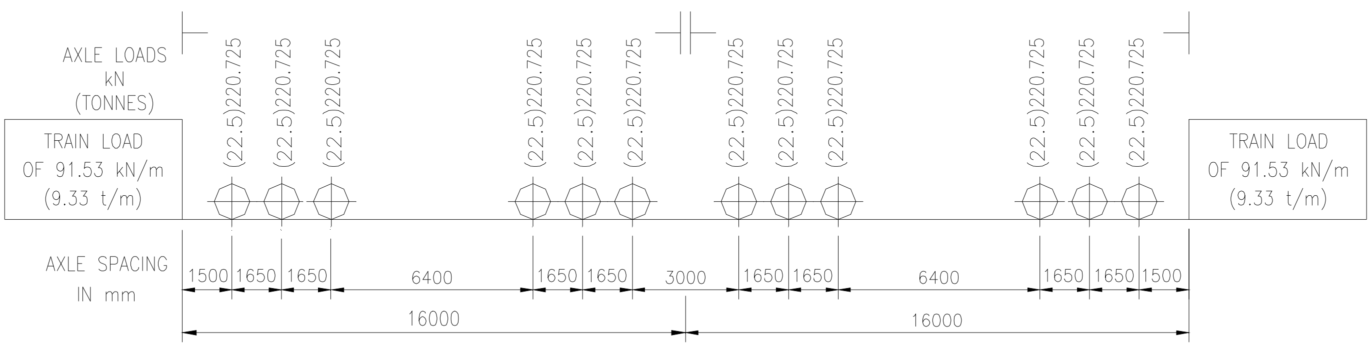
"25t LOADING-2008"

APPENDIX-XXII
SHEET 4 OF 4

COMBINATION-4: WITH DOUBLE HEADED 25t LOCO



COMBINATION-5: WITH DOUBLE HEADED 22.5t LOCO



LONGITUDINAL FORCES

TRACTIVE EFFORT PER LOCO....................50.0 TONNES (490.5 kN)
BRAKING FORCE PER LOCO AXLE............25% OF AXLE LOAD
BRAKING FORCE OF TRAIN LOAD.............13.4% OF TRAIN LOAD

"25t LOADING-2008"

MAXIMUM TRACTIVE EFFORT FOR 25t LOADING-2008 → 126t (BASED ON FIVE COMBINATION)

APPENDIX-XXIII

"25t Loading-2008"

BROAD GAUGE-1676 mm

Equivalent Uniformly Distributed Loads (EUDL) in kilo Newtons (tonnes) on each track, and Coefficient of Dynamic Augment (CDA).

For Bending Moment, L is equal to the effective span in metres. For Shear Force, L is the loaded length in metres to give the maximum Shear Force in the member under consideration.

The Equivalent Uniformly Distributed Load (EUDL) for Bending Moment (BM), for spans upto 10m, is that uniformly distributed load which produces the BM at the centre of the span equal to the absolute maximum BM developed under the standard loads. For spans above 10m, the EUDL for BM is that uniformly distributed load which produces the BM at one-sixth of the span equal to the BM developed at that section under the standard loads.

EUDL for Shear Force (SF) is that uniformly distributed load which produces SF at the end of the span equal to the maximum SF developed under the standard loads at that section.

NOTE:

(1) *Cross girders – The live load on a cross girder will be equal to half the total load for bending in a length L, equal to twice the distance over centres of cross girders.*

(2) *L for Coefficient of Dynamic Augment (CDA) shall be as laid down in clause 2.4.1.*

(3) *When loaded length lies between the values given in the table, the EUDL for Bending Moment and Shear Force can be interpolated.*

L (m)	Total load for Bending Moment		Total load for Shear Force		Impact Factor CDA= 0.15+8/(6+L)
	kN	t	kN	t	
1	2	3	4	5	6
1.0	490.50	50.00	490.50	50.00	1.000
1.5	490.50	50.00	490.50	50.00	1.000
2.0	490.50	50.00	527.29	53.75	1.000
2.5	490.50	50.00	618.03	63.00	1.000
3.0	490.50	50.00	678.56	69.17	1.000
3.5	531.02	54.13	721.72	73.57	0.992
4.0	595.96	60.75	790.98	80.63	0.950
4.5	676.89	69.00	866.52	88.33	0.912
5.0	745.56	76.00	927.05	94.50	0.877
5.5	811.58	82.73	976.59	99.55	0.846
6.0	866.52	88.33	1017.79	103.75	0.817
6.5	913.11	93.08	1052.81	107.32	0.790
7.0	952.94	97.14	1086.75	110.78	0.765

L (m)	Total load for Bending Moment		Total load for Shear Force		Impact Factor CDA= 0.15+8/(6+L)
	kN	t	kN	t	
7.5	987.57	100.67	1119.42	114.11	0.743
8.0	1017.79	103.75	1168.37	119.10	0.721
8.5	1044.47	106.47	1214.67	123.82	0.702
9.0	1068.21	108.89	1265.49	129.00	0.683
9.5	1089.40	111.05	1315.03	134.05	0.666
10.0	1108.53	113.00	1377.32	140.40	0.650
11.0	1282.66	130.75	1492.89	152.18	0.621
12.0	1377.32	140.40	1589.22	162.00	0.594
13.0	1475.13	150.37	1670.74	170.31	0.571
14.0	1558.91	158.91	1740.59	177.43	0.550
15.0	1631.60	166.32	1813.48	184.86	0.531
16.0	1708.41	174.15	1905.40	194.23	0.514
17.0	1819.56	185.48	1997.12	203.58	0.498
18.0	1889.80	192.64	2088.94	212.94	0.483
19.0	1978.28	201.66	2180.66	222.29	0.470
20.0	2065.50	210.55	2272.42	231.64	0.458
21.0	2151.63	219.33	2364.21	241.00	0.446
22.0	2236.88	228.02	2455.84	250.34	0.436
23.0	2321.34	236.63	2547.46	259.68	0.426
24.0	2405.22	245.18	2639.18	269.03	0.417
25.0	2488.40	253.66	2730.81	278.37	0.408
26.0	2571.00	262.08	2822.44	287.71	0.400
27.0	2653.21	270.46	2914.06	297.05	0.392
28.0	2735.03	278.80	3005.69	306.39	0.385
29.0	2816.35	287.09	3097.31	315.73	0.379
30.0	2897.38	295.35	3188.94	325.07	0.372
32.0	3058.66	311.79	3372.19	343.75	0.361
34.0	3058.66	328.12	3555.34	362.42	0.350
36.0	3378.17	344.36	3738.59	381.10	0.340
38.0	3218.86	360.53	3921.74	399.77	0.332
40.0	3694.74	376.63	4104.90	418.44	0.324
42.0	3852.29	392.69	4288.05	437.11	0.317
44.0	4027.20	410.52	4471.20	455.78	0.310
46.0	4210.26	429.18	4654.26	474.44	0.304
48.0	4393.31	447.84	4837.41	493.11	0.298
50.0	4576.37	466.50	5020.56	511.78	0.293
55.0	5034.00	513.15	5478.30	558.44	0.281
60.0	5491.64	559.80	5936.03	605.10	0.271
65.0	5949.27	606.45	6393.77	651.76	0.263
70.0	6406.91	653.10	6851.50	698.42	0.255
75.0	6864.55	699.75	7309.23	745.08	0.249
80.0	7322.18	746.40	7766.97	791.74	0.243
85.0	7779.82	793.05	8224.61	838.39	0.238
90.0	8237.46	839.70	8682.34	885.05	0.233
95.0	8695.09	886.35	9139.98	931.70	0.229

L (m)	Total load for Bending Moment		Total load for Shear Force		Impact Factor CDA= 0.15+8/(6+L)
	kN	t	kN	t	
100.0	9152.73	933.00	9597.61	978.35	0.225
105.0	9610.37	979.65	10055.35	1025.01	0.222
110.0	10068.00	1026.30	10512.98	1071.66	0.219
115.0	10525.64	1072.95	10970.62	1118.31	0.216
120.0	10983.28	1119.60	11428.36	1164.97	0.213
125.0	11440.91	1166.25	11885.99	1211.62	0.211
130.0	11898.55	1212.90	12343.63	1258.27	0.209

EUDL for BM and Shear Force given in this Appendix are not applicable for ballasted deck for spans upto and including 8.0m for which Appendix XXIII(a) is to be referred.

APPENDIX XXIII (a)

"25t LOADING-2008"

BROAD GAUGE 1676mm

1. Equivalent Uniformly Distributed Load (EUDL) for Bending Moment in Kilo-Newton (tonnes) for cushions of various depths and spans upto and including 8m.

For Bending Moment L is equal to the effective span in metres.

NOTE:

(1) *For intermediate values of L and cushions, the EUDL shall be arrived at by linear interpolation.*

(2) *The figures given below do not include dynamic effects.*

L	EUDL for Bending Moment							
	Cushion (mm)							
	200		300		400		600	
Metres	KN	t	kN	t	KN	t	KN	t
0.5	267.5	27.3	221.1	22.6	188.2	19.2	143.5	14.6
1.0	378.8	38.7	354.3	36.2	329.8	33.7	280.8	28.7
1.5	415.8	42.4	399.5	40.8	383.2	39.1	350.5	35.8
2.0	434.4	44.3	422.1	43.1	409.9	41.8	385.4	39.3
2.5	445.5	45.5	435.7	44.5	425.9	43.5	406.3	41.5
3.0	452.9	46.2	444.8	45.4	436.6	44.6	420.2	42.9
3.5	498.6	50.9	491.7	50.2	484.6	49.5	471.1	48.1
4.0	570.6	58.2	564.8	57.6	559.3	57.1	549.0	56.0
4.5	654.0	66.7	649.1	66.2	644.2	65.7	634.4	64.7
5.0	722.6	73.7	717.7	73.2	712.8	72.7	703.0	71.7
5.5	790.5	80.7	786.1	80.2	781.6	79.8	772.7	78.9
6.0	847.1	86.4	843.0	86.0	839.0	85.6	830.8	84.8
7.0	936.1	95.5	932.7	95.2	929.1	94.8	922.1	94.1
8.0	1002.8	102.3	999.7	102.0	996.8	101.7	990.6	101.1

2. **Equivalent Uniformly Distributed Load (EUDL) for Shear Force in Kilo-Newton (tones) for cushions of various depths and spans upto and including 8m.**

For Shear Force, **L** is the loaded length in metres to give the maximum Shear Force in the member.

NOTE:

(1) *For intermediate values of L and cushions, the EUDL shall be arrived at by linear interpolation.*

(2) *The figures given below do not include dynamic effects.*

L	EUDL for Shear Force Cushion (mm)							
	200		300		400		600	
Metres	**KN**	**t**	**KN**	**t**	**KN**	**t**	**KN**	**t**
0.5	270.1	27.5	221.3	22.6	187.5	19.1	143.6	14.6
1	379.3	38.7	354.6	36.2	330.1	33.7	281.1	28.7
1.5	416.3	42.4	400.0	40.8	383.6	39.1	350.9	35.8
2	434.9	44.3	422.6	43.1	410.4	41.8	385.7	39.3
2.5	529.0	53.9	509.3	51.9	489.7	49.9	455.3	46.4
3	604.3	61.6	588.0	59.9	571.5	58.3	539.0	54.9
3.5	658.1	67.1	644.1	65.7	630.0	64.2	601.9	61.4
4	710.6	72.4	696.1	71.0	682.4	69.6	655.9	66.9
4.5	792.3	80.8	776.0	79.1	759.7	77.4	727.1	74.1
5	860.2	87.7	845.5	86.2	831.2	84.7	801.4	81.7
5.5	915.8	93.4	902.4	92.0	889.0	90.6	862.3	87.9
6	962.2	98.1	949.8	96.8	937.6	95.6	912.9	93.1
7	1034.8	105.5	1024.4	104.4	1013.9	103.4	992.9	101.2
8	1089.5	111.1	1080.3	110.1	1071.1	109.2	1052.6	107.3

APPENDIX-XXIV

"25t Loading-2008"

BROAD GAUGE-1676 mm

Longitudinal Loads (Without Deduction for Dispersion)

NOTE: Where loaded length lies between the values given in the Table, the tractive effort or braking force can, with safety, be assumed as that for the longer loaded length.

L (Loaded length in metres)	Tractive effort		Braking force		Maximum LF	
	kN	t	kN	t	kN	t
1	2	3	4	5	6	7
1.0	103.01	10.50	61.80	6.30	103.01	10.50
1.5	103.01	10.50	61.80	6.30	103.01	10.50
2.0	206.01	21.00	122.63	12.50	206.01	21.00
2.5	206.01	21.00	122.63	12.50	206.01	21.00
3.0	206.01	21.00	122.63	12.50	206.01	21.00
3.5	245.25	25.00	165.79	16.90	245.25	25.00
4.0	309.02	31.50	184.43	18.80	309.02	31.50
4.5	309.02	31.50	184.43	18.80	309.02	31.50
5.0	309.02	31.50	184.43	18.80	309.02	31.50
5.5	309.02	31.50	184.43	18.80	309.02	31.50
6.0	309.02	31.50	184.43	18.80	309.02	31.50
6.5	326.87	33.32	220.73	22.50	326.87	33.32
7.0	326.87	33.32	220.73	22.50	326.87	33.32
7.5	326.87	33.32	220.73	22.50	326.87	33.32
8.0	408.59	41.65	275.66	28.10	408.59	41.65
8.5	408.59	41.65	275.66	28.10	408.59	41.65
9.0	408.59	41.65	275.66	28.10	408.59	41.65
9.5	412.02	42.00	275.66	28.10	412.02	42.00
10.0	490.30	49.98	331.58	33.80	490.30	49.98
11.0	490.30	49.98	331.58	33.80	490.30	49.98
12.0	515.03	52.50	331.58	33.80	515.03	52.50
13.0	618.03	63.00	331.58	33.80	618.03	63.00
14.0	618.03	63.00	367.88	37.50	618.03	63.00
15.0	618.03	63.00	367.88	37.50	618.03	63.00
16.0	618.03	63.00	386.51	39.40	618.03	63.00
17.0	618.03	63.00	386.51	39.40	618.03	63.00
18.0	653.74	66.64	441.45	45.00	653.74	66.64
19.0	653.74	66.64	441.45	45.00	653.74	66.64
20.0	735.46	74.97	496.39	50.60	735.46	74.97
21.0	735.46	74.97	499.33	50.90	735.46	74.97
22.0	735.46	74.97	511.10	52.10	735.46	74.97
23.0	735.46	74.97	523.12	53.38	735.46	74.97
24.0	735.46	74.97	551.32	56.20	735.46	74.97
25.0	824.04	84.00	551.32	56.20	824.04	84.00
26.0	824.04	84.0	560.15	57.10	824.04	84.0

L (Loaded length in metres)	Tractive effort		Braking force		Maximum LF	
	kN	t	kN	t	kN	t
27.0	927.05	94.50	572.90	58.40	927.05	94.50
28.0	927.05	94.50	607.05	61.88	927.05	94.50
29.0	980.61	99.96	662.18	67.50	980.61	99.96
30.0	980.61	99.96	662.18	67.50	980.61	99.96
32.0	980.61	99.96	680.81	69.40	980.61	99.96
34.0	980.61	99.96	735.75	75.00	980.61	99.96
36.0	1030.05	105.00	735.75	75.00	1030.05	105.00
38.0	1133.06	115.50	760.28	77.50	1133.06	115.50
40.0	1236.06	126.00	784.80	80.00	1236.06	126.00
42.0	1236.06	126.00	809.33	82.50	1236.06	126.00
44.0	1236.06	126.00	833.85	85.00	1236.06	126.00
46.0	1236.06	126.00	858.38	87.50	1236.06	126.00
48.0	1236.06	126.00	882.90	90.00	1236.06	126.00
50.0	1236.06	126.00	907.43	92.50	1236.06	126.00
55.0	1236.06	126.00	968.25	98.70	1236.06	126.00
60.0	1236.06	126.00	1030.05	105.00	1236.06	126.00
65.0	1236.06	126.00	1090.87	111.20	1236.06	126.00
70.0	1236.06	126.00	1152.68	117.50	1236.06	126.00
75.0	1236.06	126.00	1213.50	123.70	1236.06	126.00
80.0	1236.06	126.00	1275.30	130.00	1275.30	130.00
85.0	1236.06	126.00	1336.12	136.20	1336.12	136.20
90.0	1236.06	126.00	1397.93	142.50	1397.93	142.50
95.0	1236.06	126.00	1458.75	148.70	1458.75	148.70
100.0	1236.06	126.00	1520.55	155.00	1520.55	155.00
105.0	1236.06	126.00	1581.37	161.20	1581.37	161.20
110.0	1236.06	126.00	1643.18	167.50	1643.18	167.50
115.0	1236.06	126.00	1704.00	173.70	1704.00	173.70
120.0	1236.06	126.00	1765.80	180.00	1765.80	180.00
125.0	1236.06	126.00	1826.62	186.20	1826.62	186.20
130.0	1236.06	126.00	1888.43	192.50	1888.43	192.50

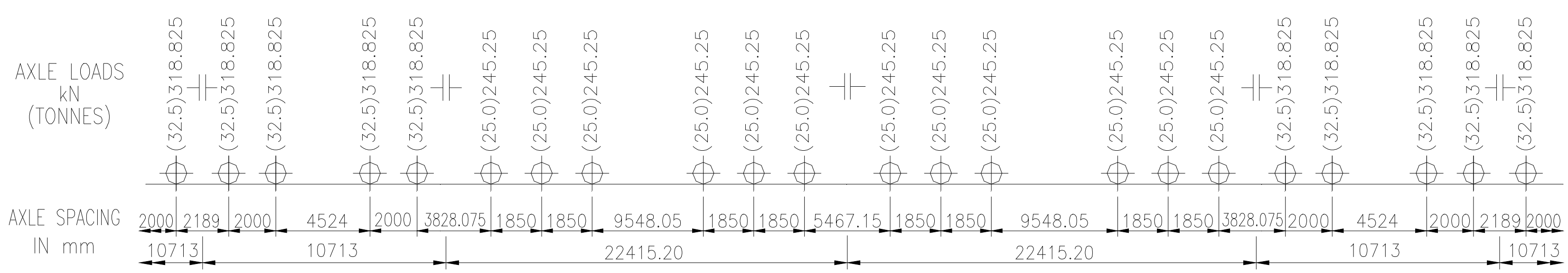
DERAILMENT LOADS FOR BALLASTED DECK BRIDGES
(25t Loading-2008)

S.N.	Condition and approach	Bridges with guard rails	Bridges without guard rails
1.	**Ultimate –** The load at which a derailed vehicle shall not cause collapse of any major element.	a) Two vertical line loads of 75 kN/m each 1.6m* apart parallel to the track in the most unfavorable position inside an area of 1.3m on either side of track centre line. b) A single load of 200 kN acting on an area of 1.3m on either side of track centre line in the most unfavorable position.	a) Two vertical line loads of 75 kN/m each 1.6m* apart parallel to the track in the most unfavorable position inside an area of 2.25m on either side of track centre line. b) A single line load of 200 kN acting on an area of 2.25m on either side of track centre line in the most unfavorable position.
2.	**Stability –** The structure shall not overturn.	A vertical line load of 94 kN/m with a total length of 20m acting on the edge of the structure under consideration.	A vertical line load of 94 kN/m with a total length of 20m acting on the edge of the structure under consideration

** The distance 1.6m is based on Broad Gauge distance 1.676m as adopted for derailment loads for MBG-1987 loading and HM loading.*

APPENDIX XXVI
SHEET 1 OF 4

COMBINATION-1: DOUBLE HEADED DIESEL LOCO



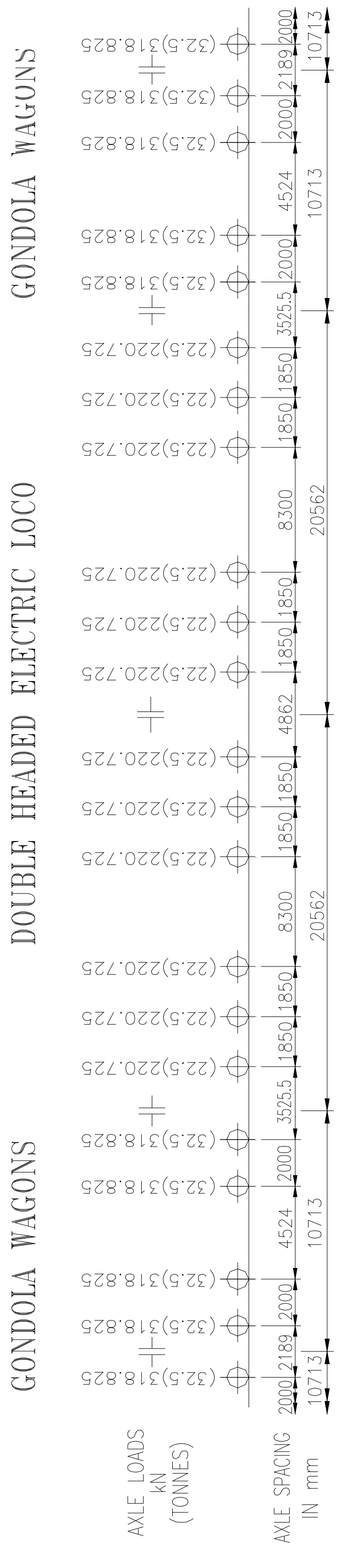
LONGITUDINAL FORCES

TRACTIVE EFFORT PER LOCO....................63.0 TONNES (618.03 kN)
BRAKING FORCE PER LOCO AXLE............25% OF AXLE LOAD
BRAKING FORCE OF TRAIN LOAD.............13.4% OF TRAIN LOAD

"DFC LOADING (32.5t AXLE LOAD)"

APPENDIX
XXVI
SHEET 2 OF 4

COMBINATION-2: DOUBLE HEADED ELECTRIC LOCO (2WAG9H)



LONGITUDINAL FORCES

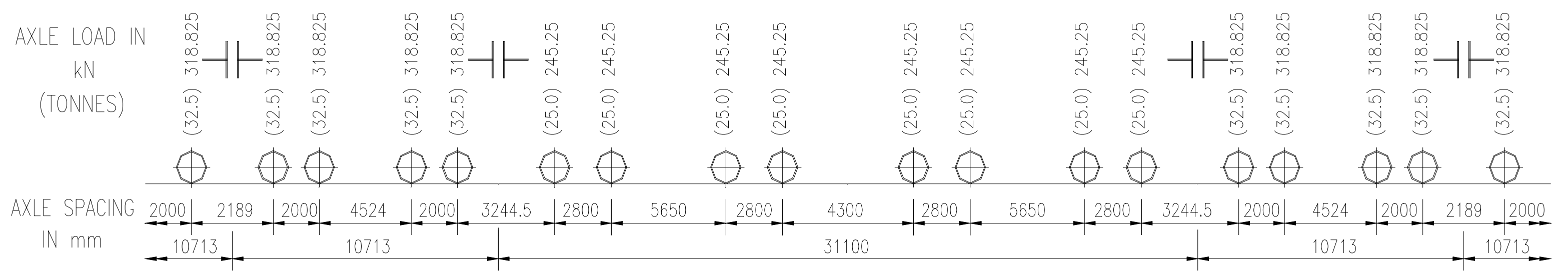
TRACTIVE EFFORT PER LOCO..................52.0 TONNES (510.12 kN)
BRAKING FORCE PER LOCO AXLE............25% OF AXLE LOAD
BRAKING FORCE OF TRAIN LOAD............13.4% OF TRAIN LOAD

"DFC LOADING (32.5t AXLE LOAD)"

APPENDIX XXVI
SHEET 3 OF 4

COMBINATION–3: ELECTRIC LOCO [(Bo–Bo)+(Bo–Bo)]

GONDOLA WAGONS　　ELECTRIC LOCO [(Bo–Bo)+(Bo–Bo)]　　GONDOLA WAGONS



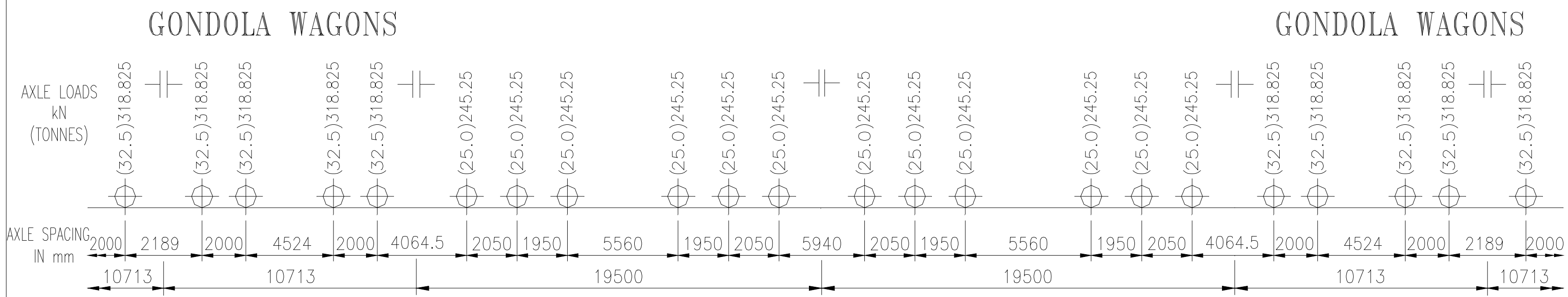
LONGITUDINAL FORCES

TRACTIVE EFFORT PER LOCO--------------- 84.0 TONNES (824.04 kN)
BRAKING FORCE PER LOCO AXLE ----------- 25% OF AXLE LOAD
BRAKING FORCE OF TRAIN LOAD ----------- 13.4% OF TRAIN LOAD

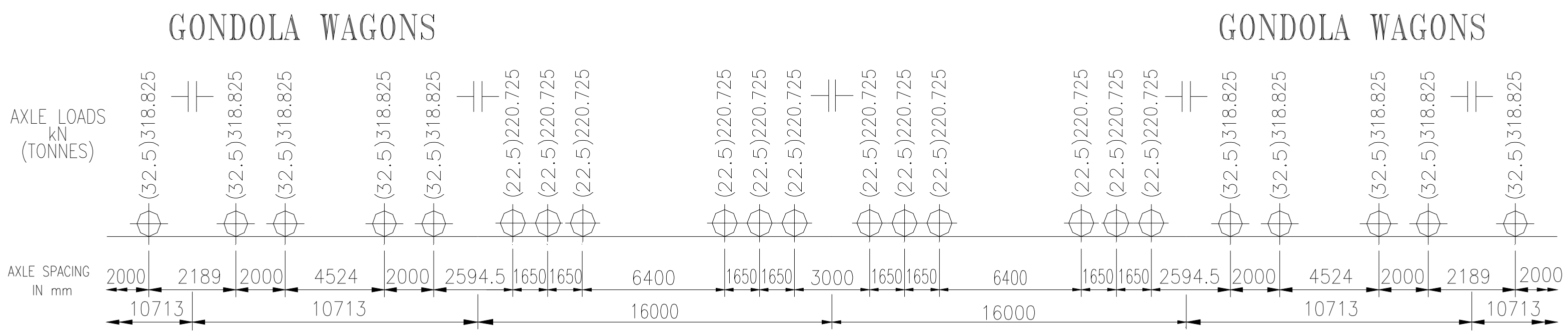
"DFC LOADING (32.5t AXLE LOAD)"

APPENDIX XXVI
SHEET 4 OF 4

COMBINATION-4: WITH DOUBLE HEADED 25t LOCO



COMBINATION-5: WITH DOUBLE HEADED 22.5t LOCO



LONGITUDINAL FORCES

TRACTIVE EFFORT PER LOCO ------ 50.0 TONNES (490.5 kN)
BRAKING FORCE PER LOCO AXLE --- 25% OF AXLE LOAD
BRAKING FORCE OF TRAIN LOAD-----13.4% OF TRAIN LOAD

"DFC LOADING (32.5t AXLE LOAD)"

MAXIMUM TRACTIVE EFFORT FOR "DFC LOADING (32.5t AXLE LOAD)" → 126t (BASED ON FIVE COMBINATION)

"DFC loading (32.5t axle load)"

BROAD GAUGE-1676 mm

Equivalent Uniformly Distributed Loads (EUDL) in kilo Newtons (tonnes) on each track, and Coefficient of Dynamic Augment (CDA).

For Bending Moment, L is equal to the effective span in metres. For Shear Force, L is the loaded length in metres to give the maximum Shear Force in the member under consideration.

The Equivalent Uniformly Distributed Load (EUDL) for Bending Moment (BM), for spans upto 10m, is that uniformly distributed load which produces the BM at the centre of the span equal to the absolute maximum BM developed under the standard loads. For spans above 10m, the EUDL for BM is that uniformly distributed load which produces the BM at one-sixth of the span equal to the BM developed at that section under the standard loads.

EUDL for Shear Force (SF) is that uniformly distributed load which produces SF at the end of the span equal to the maximum SF developed under the standard loads at that section.

NOTE:

(4) *Cross girders – The live load on a cross girder will be equal to half the total load for bending in a length L, equal to twice the distance over centres of cross girders.*

(5) *L for Coefficient of Dynamic Augment (CDA) shall be as laid down in clause 2.4.1.*

(6) *When loaded length lies between the values given in the table, the EUDL for Bending Moment and Shear Force can be interpolated.*

L (m)	Total load for Bending Moment		Total load for Shear Force		CDA= 0.15+8/(6+L)
	kN	t	kN	t	
1	2	3	4	5	6
1.0	637.00	65.00	637.00	65.00	1.000
1.5	637.00	65.00	637.00	65.00	1.000
2.0	637.00	65.00	637.00	65.00	1.000
2.5	637.00	65.00	764.40	78.00	1.000
3.0	637.00	65.00	849.37	86.67	1.000
3.5	652.97	66.63	910.03	92.86	0.992
4.0	716.67	73.13	955.50	97.50	0.950
4.5	770.67	78.64	1034.88	105.60	0.912
5.0	843.98	86.12	1122.49	114.54	0.877
5.5	940.90	96.01	1194.23	121.86	0.846
6.0	1021.75	104.26	1253.91	127.95	0.817
6.5	1090.15	111.24	1334.96	136.22	0.790
7.0	1148.76	117.22	1421.59	145.06	0.765

L (m)	Total load for Bending Moment		Total load for Shear Force		CDA= 0.15+8/(6+L)
	kN	t	kN	t	
7.5	1199.52	122.40	1496.66	152.72	0.743
8.0	1261.46	128.72	1562.41	159.43	0.721
8.5	1334.56	136.18	1620.43	165.35	0.702
9.0	1399.73	142.83	1671.88	170.60	0.683
9.5	1458.34	148.81	1718.04	175.31	0.666
10.0	1511.16	154.20	1759.49	179.54	0.650
11.0	1687.85	172.23	1847.79	188.55	0.621
12.0	1759.49	179.54	1959.22	199.92	0.594
13.0	1827.21	186.45	2067.60	210.98	0.571
14.0	1924.23	196.35	2192.95	223.77	0.550
15.0	2008.31	204.93	2305.65	235.27	0.531
16.0	2132.09	217.56	2440.30	249.01	0.514
17.0	2268.99	231.53	2562.70	261.50	0.498
18.0	2394.83	244.37	2703.43	275.86	0.483
19.0	2536.93	258.87	2829.36	288.71	0.470
20.0	2664.91	271.93	2942.65	300.27	0.458
21.0	2780.65	283.74	3045.25	310.74	0.446
22.0	2885.90	294.48	3155.11	321.95	0.436
23.0	2982.04	304.29	3267.12	333.38	0.426
24.0	3088.37	315.14	3385.12	345.42	0.417
25.0	3194.11	325.93	3504.48	357.60	0.408
26.0	3298.88	336.62	3624.14	369.81	0.400
27.0	3412.65	348.23	3749.48	382.60	0.392
28.0	3518.20	359.00	3874.53	395.36	0.385
29.0	3631.10	370.52	4004.57	408.63	0.379
30.0	3743.70	382.01	4125.90	421.01	0.372
32.0	3972.72	405.38	4345.71	443.44	0.361
34.0	4197.34	428.30	4574.64	466.80	0.350
36.0	4425.29	451.56	4813.47	491.17	0.340
38.0	4661.66	475.68	5057.49	516.07	0.332
40.0	4897.35	499.73	5309.05	541.74	0.324
42.0	5134.81	523.96	5541.51	565.46	0.317
44.0	5364.72	547.42	5769.55	588.73	0.310
46.0	5574.53	568.83	6005.44	612.80	0.304
48.0	5788.27	590.64	6245.64	637.31	0.298
50.0	6017.69	614.05	6492.21	662.47	0.293
55.0	6612.35	674.73	7076.78	722.12	0.281
60.0	7164.39	731.06	7675.36	783.20	0.271
65.0	7736.02	789.39	8267.97	843.67	0.263
70.0	8357.44	852.80	8862.73	904.36	0.255
75.0	8974.94	915.81	9457.10	965.01	0.249
80.0	9557.16	975.22	10051.08	1025.62	0.243
85.0	10177.89	1038.56	10650.05	1086.74	0.238
90.0	10761.97	1098.16	11238.25	1146.76	0.233
95.0	11351.44	1158.31	11841.05	1208.27	0.229

L (m)	Total load for Bending Moment		Total load for Shear Force		CDA= 0.15+8/(6+L)
	kN	t	kN	t	
100.0	11944.24	1218.80	12428.46	1268.21	0.225
105.0	12539.88	1279.58	13030.47	1329.64	0.222
110.0	13126.71	1339.46	13617.98	1389.59	0.219
115.0	13707.85	1398.76	14218.82	1450.90	0.216
120.0	14300.75	1459.26	14806.53	1510.87	0.213
125.0	14877.09	1518.07	15406.38	1572.08	0.211
130.0	15464.89	1578.05	15996.93	1632.34	0.209

EUDL for BM and Shear Force given in this Appendix are not applicable for ballasted deck for spans upto and including 8.0m for which Appendix XXVI(a) is to be referred.

APPENDIX XXVII (a)

"DFC loading (32.5t axle load)"

BROAD GAUGE 1676mm

1. Equivalent Uniformly Distributed Load (EUDL) for Bending Moment in Kilo-Newton (tonnes) for cushions of various depths and spans upto and including 8m.

For Bending Moment L is equal to the effective span in metres.

NOTE:

(3) *For intermediate values of L and cushions, the EUDL shall be arrived at by linear interpolation.*

(4) *The figures given below do not include dynamic effects.*

	EUDL for Bending Moment							
	Cushion (mm)							
L	**200**		**300**		**400**		**600**	
Metres	**KN**	**t**	**kN**	**t**	**KN**	**t**	**KN**	**t**
0.5	350.74	35.79	287.43	29.33	243.53	24.85	186.49	19.03
1.0	492.45	50.25	460.60	47.00	428.75	43.75	365.05	37.25
1.5	540.57	55.16	519.40	53.00	498.13	50.83	455.70	46.50
2.0	564.68	57.62	548.80	56.00	532.83	54.37	500.98	51.12
2.5	579.18	59.10	566.44	57.80	553.70	56.50	528.22	53.90
3.0	588.78	60.08	578.20	59.00	567.52	57.91	546.35	55.75
3.5	608.58	62.10	599.47	61.17	590.35	60.24	572.12	58.38
4.0	680.51	69.44	672.48	68.62	664.54	67.81	648.56	66.18
4.5	738.53	75.36	731.57	74.65	724.51	73.93	710.30	72.48
5.0	815.07	83.17	808.50	82.50	802.13	81.85	789.39	80.55
5.5	914.73	93.34	908.95	92.75	903.07	92.15	891.51	90.97
6.0	997.64	101.80	992.25	101.25	987.06	100.72	976.37	99.63
7.0	1128.08	115.11	1123.96	114.69	1119.06	114.19	1139.35	116.26
8.0	1243.42	126.88	1239.50	126.48	1235.78	126.10	1227.65	125.27

2. **Equivalent Uniformly Distributed Load (EUDL) for Shear Force in Kilo-Newton (tones) for cushions of various depths and spans upto and including 8m.**

For Shear Force, **L** is the loaded length in metres to give the maximum Shear Force in the member.

NOTE:

(3) *For intermediate values of L and cushions, the EUDL shall be arrived at by linear interpolation.*

(4) *The figures given below do not include dynamic effects.*

L	EUDL for Shear							
	Cushion (mm)							
	200		300		400		600	
Metres	KN	t	kN	t	KN	t	KN	t
0.5	350.74	35.79	287.53	29.34	243.53	24.85	186.49	19.03
1.0	492.35	50.24	460.50	46.99	428.65	43.74	365.05	37.25
1.5	540.57	55.16	519.40	53.00	498.13	50.83	455.70	46.50
2.0	564.68	57.62	548.80	56.00	532.83	54.37	500.98	51.12
2.5	648.76	66.20	623.28	63.60	597.80	61.00	546.84	55.80
3.0	752.93	76.83	731.67	74.66	710.50	72.50	667.97	68.16
3.5	827.32	84.42	809.19	82.57	790.96	80.71	754.60	77.00
4.0	883.18	90.12	867.30	88.50	851.42	86.88	819.67	83.64
4.5	941.78	96.10	924.92	94.38	908.75	92.73	878.08	89.60
5.0	1035.76	105.69	1016.65	103.74	998.82	101.92	959.42	97.90
5.5	1115.44	113.82	1097.99	112.04	1080.55	110.26	1045.86	106.72
6.0	1181.68	120.58	1165.81	118.96	1149.74	117.32	1117.98	114.08
7.0	1339.07	136.64	1320.75	134.77	1302.62	132.92	1266.16	129.20
8.0	1490.58	152.10	1474.61	150.47	1458.24	148.80	1430.41	145.96

APPENDIX-XXVIII

"DFC loading (32.5t axle load)"
BROAD GAUGE-1676 mm
Longitudinal Loads (Without Deduction for Dispersion)

NOTE: Where loaded length lies between the values given in the Table, the tractive effort or braking force can, with safety, be assumed as that for the longer loaded length.

L (Loaded length in metres)	Tractive effort		Braking force		Maximum LF	
	kN	t	kN	t	kN	t
1	2	3	4	5	6	7
1.0	102.90	10.50	61.25	6.25	102.90	10.50
1.5	102.90	10.50	61.25	6.25	102.90	10.50
2.0	205.80	21.00	122.50	12.50	205.80	21.00
2.5	205.80	21.00	122.50	12.50	205.80	21.00
3.0	205.80	21.00	122.50	12.50	205.80	21.00
3.5	244.90	24.99	165.42	16.88	244.90	24.99
4.0	308.70	31.50	183.75	18.75	308.70	31.50
4.5	308.70	31.50	183.75	18.75	308.70	31.50
5.0	308.70	31.50	183.75	18.75	308.70	31.50
5.5	308.70	31.50	183.75	18.75	308.70	31.50
6.0	308.70	31.50	208.05	21.23	308.70	31.50
6.5	326.54	33.32	220.50	22.50	326.54	33.32
7.0	326.54	33.32	220.50	22.50	326.54	33.32
7.5	326.54	33.32	220.50	22.50	326.54	33.32
8.0	408.17	41.65	275.67	28.13	408.17	41.65
8.5	408.17	41.65	275.67	28.13	408.17	41.65
9.0	408.17	41.65	275.67	28.13	408.17	41.65
9.5	411.60	42.00	275.67	28.13	411.60	42.00
10.0	489.80	49.98	330.75	33.75	489.80	49.98
11.0	489.80	49.98	330.75	33.75	489.80	49.98
12.0	514.50	52.50	330.75	33.75	514.50	52.50
13.0	617.40	63.00	367.50	37.50	617.40	63.00
14.0	617.40	63.00	367.50	37.50	617.40	63.00
15.0	617.40	63.00	367.50	37.50	617.40	63.00
16.0	617.40	63.00	385.92	39.38	617.40	63.00
17.0	617.40	63.00	385.92	39.38	617.40	63.00
18.0	653.07	66.64	441.00	45.00	653.07	66.64
19.0	653.07	66.64	441.00	45.00	653.07	66.64
20.0	734.71	74.97	496.17	50.63	734.71	74.97
21.0	734.71	74.97	496.17	50.63	734.71	74.97
22.0	734.71	74.97	538.80	54.98	734.71	74.97
23.0	734.71	74.97	538.80	54.98	734.71	74.97
24.0	734.71	74.97	581.53	59.34	734.71	74.97
25.0	823.20	84.00	581.53	59.34	823.20	84.00
26.0	823.20	84.00	581.53	59.34	823.20	84.00

L (Loaded length in metres)	Tractive effort		Braking force		Maximum LF	
	kN	t	kN	t	kN	t
27.0	926.10	94.50	581.53	59.34	926.10	94.50
28.0	926.10	94.50	606.42	61.88	926.10	94.50
29.0	979.61	99.96	661.50	67.50	979.61	99.96
30.0	979.61	99.96	661.50	67.50	979.61	99.96
32.0	979.61	99.96	704.23	71.86	979.61	99.96
34.0	979.61	99.96	746.86	76.21	979.61	99.96
36.0	1029.00	105.00	752.25	76.76	1029.00	105.00
38.0	1131.90	115.50	752.25	76.76	1131.90	115.50
40.0	1234.80	126.00	794.88	81.11	1234.80	126.00
42.0	1234.80	126.00	837.61	85.47	1234.80	126.00
44.0	1234.80	126.00	880.24	89.82	1234.80	126.00
46.0	1234.80	126.00	922.96	94.18	1234.80	126.00
48.0	1234.80	126.00	948.44	96.78	1234.80	126.00
50.0	1234.80	126.00	991.07	101.13	1234.80	126.00
55.0	1234.80	126.00	1050.95	107.24	1234.80	126.00
60.0	1234.80	126.00	1131.02	115.41	1234.80	126.00
65.0	1234.80	126.00	1221.67	124.66	1234.80	126.00
70.0	1234.80	126.00	1289.88	131.62	1289.88	131.62
75.0	1234.80	126.00	1387.09	141.54	1387.09	141.54
80.0	1234.80	126.00	1460.59	149.04	1460.59	149.04
85.0	1234.80	126.00	1520.47	155.15	1520.47	155.15
90.0	1234.80	126.00	1605.83	163.86	1605.83	163.86
95.0	1234.80	126.00	1691.19	172.57	1691.19	172.57
100.0	1234.80	126.00	1776.54	181.28	1776.54	181.28
105.0	1234.80	126.00	1856.51	189.44	1856.51	189.44
110.0	1234.80	126.00	1947.26	198.70	1947.26	198.70
115.0	1234.80	126.00	2015.37	205.65	2015.37	205.65
120.0	1234.80	126.00	2112.59	215.57	2112.59	215.57
125.0	1234.80	126.00	2186.09	223.07	2186.09	223.07
130.0	1234.80	126.00	2245.96	229.18	2245.96	229.18

APPENDIX -XXIX

DERAILMENT LOADS FOR BALLASTED DECK BRIDGES
(DFC loading, 32.5t axle load)

S.N.	Condition and approach	Bridges with guard rails	Bridges without guard rails
1.	**Ultimate –** The load at which a derailed vehicle shall not cause collapse of any major element.	a) Two vertical line loads of 100 kN/m each 1.6m* apart parallel to the track in the most unfavorable position inside an area of 1.3m on either side of track centre line. b) A single load of 260 kN acting on an area of 1.3m on either side of track centre line in the most unfavorable position.	a) Two vertical line loads of 100 kN/m each 1.6m* apart parallel to the track in the most unfavorable position inside an area of 2.25m on either side of track centre line. b) A single line load of 260 kN acting on an area of 2.25m on either side of track centre line in the most unfavorable position.
2.	**Stability –** The structure shall not overturn.	A vertical line load of 122 kN/m with a total length of 20m acting on the edge of the structure under consideration.	A vertical line load of 122 kN/m with a total length of 20m acting on the edge of the structure under consideration

** The distance 1.6m is based on Broad Gauge distance 1.676m as adopted for derailment loads for MBG-1987 loading and HM loading.*